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# Review of Wildlife Resources of Vandenberg Air Force Base, California

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# **Review of Wildlife Resources of Vandenberg Air Force Base, California**

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## ABSTRACT

Wildlife resources are reviewed for purposes of developing a Base Biological Monitoring Program (BMP) for Vandenberg Air Force Base (VAFB) in Santa Barbara County, California. The review and recommendations were prepared by review of applicable scientific literature and environmental documents for VAFB, discussing information needs with natural resource management professionals at VAFB, and observations of base field conditions. This process found that there are 29 federally listed vertebrates (endangered, threatened, or Category 2) that occur or may occur in the vicinity of VAFB. There are also 63 other state listed or regionally declining species that may occur in the vicinity of VAFB. Habitats of VAFB represent a very valuable environmental resource for rare and declining wildlife in California. However, little information is available on VAFB wildlife resources other than lists of species that occur or are expected to occur. Recommendations are presented to initiate a long-term wildlife monitoring program at VAFB to provide information for environmental impact assessment and wise land use planning.

## TABLE OF CONTENTS

Abstract.....	i
Acknowledgements.....	iii
1.0 Introduction.....	1
2.0 Wildlife Resources of Vandenberg Air Force Base.....	2
2.1 Herpetofauna.....	2
2.2 Avifauna.....	7
2.3 Mammalian fauna.....	17
3.0 Conclusions.....	29
4.0 Recommendations.....	30
5.0 Literature Cited.....	32
6.0 Appendix 1. Rationale for long-term monitoring of wildlife resources.....	56

## LIST OF TABLES

Table 1. Amphibian and reptilian species of special concern that may occur on VAFB or be affected by VAFB activities .....	3
Table 2. Potential avian species of special concern that may occur on VAFB or be affected by VAFB activities .....	8
Table 3. Mammalian species of special concern that may occur on VAFB or be affected by VAFB activities .....	18

## LIST OF FIGURES

Figure 1. Long-term population fluctuations.....	58
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## 1.0 Introduction

This document provides a review of wildlife resources for the purposes of recommending the development of the wildlife section to the Base Biological Monitoring Program (BMP) for Vandenberg Air Force Base (VAFB). Wildlife resources emphasized are those amphibian, reptilian, avian, and mammalian species that use the property of VAFB; species of special concern that only use offshore waters are briefly mentioned. The review and recommendations were prepared by reviewing applicable scientific literature and environmental documents for VAFB, discussing information needs of the natural resources staff of 1 STRAD/ET, and observing field conditions associated with visits to areas of VAFB including avian surveys in riparian habitat (Breininger 1988).

The compilation of species of special concern at VAFB led to the conclusion that VAFB represents an important area for maintenance of regional diversity. VAFB is in the transition zone between northern and southern California situated near the southern end of the coast ranges and western end of the transverse ranges. There are many species of wildlife occurring here, and many of these species reach their northern or southern limits within the area, making the area of great ecological and biogeographical interest (Coulombe and Cooper 1976). Given the regional diversity and the large number of species of special concern on VAFB, wildlife resource management is a very important issue. The staff of 1 STRAD/ET is greatly in need of a long-term wildlife monitoring program (Appendix 1).

## 2.0 Wildlife Resources of Vandenberg Air Force Base

Numerous species of special concern including state and federally listed species, species under review (Category 1, 2) by the U.S. Fish and Wildlife Service, and other regionally rare and declining wildlife (Coulombe and Cooper 1976, Coulombe and Mahrtdt 1976, Remsen 1978, Tate 1981, Lehman 1982, Tate and Tate 1982, Howald et al. 1985, Williams 1986, URS Corp. 1987) have been previously identified for VAFB. The following discussion emphasizes such species along with a few species that are recreationally important beyond their aesthetic value (i.e., deer) or are harmful to the natural integrity of VAFB (i.e., feral swine).

### 2.1 Herpetofauna

Amphibians and reptiles are now being recognized as valuable indicators of environmental quality (Orser and Shure 1972, Brinson et al. 1981). The herpetofaunal components of VAFB includes several species of concern (Table 1); however, their distribution on VAFB is poorly documented. Amphibians often require specific habitats for adult and larval life stages; habitat for the adult and/or larval life stages can limit the population. Some amphibians require temporary ponds that are large enough or stay flooded long enough so that young can undergo metamorphosis into an adult stage. Some permanent fresh water areas may not be very suitable, since other aquatic animals might predate or compete with their young (Smith 1983). There is a need to identify the distribution of areas critical to sustaining amphibian populations of species of special concern. Studies should determine all or many of the critical locations that can then be used to prepare maps of critical habitat. Management and long-term monitoring needs of critical habitats can then be determined.

Table 1. Amphibian and reptilian species of special concern that may occur on VAFB or may be affected by VAFB activities.

Common name	Scientific name	Federal status	State status
California tiger salamander	<i>Ambystoma tigrinum californiense</i>	C2	D
California newt	<i>Taricha torosa</i>		
California tree frog	<i>Hyla cadaverina</i>		
Red-legged frog	<i>Rana aurora draytoni</i>	C2	D
Foothill yellow-legged frog	<i>Rana boylei</i>		
Western spadefoot	<i>Scaphiopus hammondi</i>		
Western pond turtle	<i>Clemmys marmorata pallida</i>	C2	D
Leatherback turtle	<i>Dermochelys coriacea</i>	E	
Loggerhead	<i>Caretta caretta</i>	T	
Green turtle	<i>Chelonia mydas</i>	T	
San Diego horned toad	<i>Phrynosoma coronatum blainvillei</i>	C2	D
Black legless lizard	<i>Anniella pulchra nigra</i>	C2	D
Sharp tailed snake	<i>Contia tenuis</i>		
Two-striped garter snake	<i>Thamnophis couchii</i>		
California mountain kingsnake	<i>Lampropeltis zonata</i>		
California black-headed snake	<i>Tantilla planiceps</i>		

E=Endangered 50 CFR 17.11 and 17.12

T=Threatened 50 CFR 17.11 and 17.12

C2=Federal candidate species, Category 2 50 CFR 181

D=Special animal, Natural Diversity Data Base, California Fish and Game, 3/85



Hayes and Jennings (1986) cite data suggesting that some western amphibian populations exist in small demes, and maintenance of the deme's size depends on recruitment from within the population and immigration from nearby populations. A deme here refers to a small, generally interbreeding population that is part of a larger population. Extinctions of local demes result in greater distance between such populations (Moyle 1974, Terborgh 1976) which may decrease chances of immigration to other populations (Hayes and Jennings 1986). Local extinctions occur more frequently in small populations (Whitcomb et al. 1976, Fritz 1979). Immigration may be important for maintaining genetic diversity among populations. Critical habitat, therefore, should not just include known breeding ponds but consider corridors for dispersal among populations. Many amphibians have limited capability for dispersal compared to other groups such as birds. Conservation of endangered wildlife and maintenance of native diversity is not only dependent upon the habitat content within boundaries of protected areas but is also dependent upon the landscape, particularly features facilitating or inhibiting dispersal (Willis 1974, Diamond 1975, Garland and Bradley 1984, Mader 1984, Noss and Harris 1986).

There are no records of the California tiger salamander on VAFB, but there are records of the species within five miles of the base, and it is expected to be present on VAFB (Coulombe and Copper 1976, Coulombe and Mahrtdt 1976, Mahrtdt et al. 1976, Sam Sweet and Marc Hayes, pers. comm.). Preferred habitat includes oak savannah, woodlands, and grasslands within 0.5 to 1.0 miles from large, fresh water, temporary ponds used for breeding. The species can easily be overlooked because adults are secretive, nocturnal, and use burrows of several mammalian species during the dry season. Adults emerge briefly after prolonged rains in late fall and migrate to temporary fresh water

ponds to mate and lay eggs. These ponds must be large enough so that larvae can develop and metamorphosis before ponds dry up in late spring or early summer. The California newt also may occur on VAFB, since it too has been found in nearby areas (Coulombe and Cooper 1976, Coulombe and Mahrtdt 1976, Mahrtdt et al. 1976, Sam Sweet, pers. comm.).

The southwestern toad (*Bufo microcaphus*) probably does not occur on VAFB. It is unknown if the yellow-legged frog occurs on VAFB (Sam Sweet, pers. comm.). This frog might occur on some smaller drainages on VAFB, since it is a species that requires flowing water with a hard substrate, cobble size or bigger, for reproduction (Storer 1925, Fitch 1938, Zweifel 1955, Marc Hayes, pers. comm.). The red-legged frog definitely occurs on VAFB in areas such as the San Antonio Creek, Santa Ynez River, and Shuman and Canada Honda Creeks (Coulombe and Cooper 1976, Coulombe and Mahrtdt 1976, Dial 1980, Marc Hayes and Sam Sweet, pers. comm.). The species requires large enough pools with over-hanging vegetation, particularly *Salix lasiolepis*, found near the end of several drainages on VAFB (Zweifel 1955, Marc Hayes, pers. comm.).

The western spadefoot is probably on VAFB (Coulombe and Cooper 1976) and can also be overlooked because adults remain buried in sand for much of the year (Sam Sweet and Marc Hayes, pers. comm.). The species uses small temporary ponds for breeding and is characteristic of open vegetation and short grass where the soil is sandy.

Little information is available about the western pond turtle north of Ventura County. It is present in perennial streams, ponds, and lakes on VAFB, and it has been reported in San Antonio Creek, Santa Ynez River, and the Canyon Lakes (Coulombe and Cooper 1976, Coulombe and Mahrtdt 1976, Mahrtdt et al. 1976). There is a population of the California legless lizard on base (Sam Sweet, pers. comm.), but most or all of the darker color morph are to

the north (Marc Hayes, pers. comm.). Other potential species of special concern include the California mountain kingsnake and the California black-headed snake (Coulombe and Cooper 1976, Coulombe and Mahrtdt 1976, Marc Hayes, pers. comm.). The latter species is poorly understood; it occurs in shrubby chaparral and coastal scrub. The few records available for the species have been after unusual late summer rains (Marc Hayes, pers. comm.). Marine turtles are probably rare off the stretch of coastline that includes VAFB (Jones and Stokes Associates, Inc. 1981). Other species of special concern may occupy relict habitats on VAFB such as the sharp-tailed snake, which may be in the unique Tranquillon Mountain area (Sam Sweet, pers. comm.).

Some information beyond presence/absence and location is needed for many species of special concern. Some examples of the considerations beyond mapping for habitat and species management on VAFB are described below.

Adults of red-legged frogs are primarily terrestrial but need nearby water that is deep enough to escape predators (Gregory 1979) and so occur in high numbers only near suitable waters. Prior to modifications to the San Antonio Creek several years ago, red-legged frogs were abundant at the lower sections of the creek (Marc Hayes, pers. comm.). A follow-up of actions associated with the changes does not appear to have been conducted, but impacts could have occurred to riparian areas. For example, modifications were performed to the 13th Street bridge and spilled equipment oil was observed near the stream bed in the dewatering area downstream of the bridge (Crisologo 1984). It has been documented that there is an inverse correlation between the abundance of the endemic frogs and human-induced modifications of stream habitats (Moyle 1974). Interactions with the exotic bullfrog (*Rana catesbeiana*) have been suggested to cause declines of species such as the yellow-legged and red-

legged frog (Moyle 1973, Bury and Luckenbach 1976). Other possibilities causing decline include alteration of critical stream habitat features (Hayes and Jennings 1986) and interactions with non-native fishes (Hammerson 1982, Hayes and Jennings 1986). Dial (1980) suggested that some non-native fish species also negatively affect the stickleback populations on VAFB.

Commercial exploitation of frogs may also have been a factor in the past (Jennings and Hayes 1985), as well as catastrophic mortality (such as scouring floods, drought, or oxygen depletion [Bradford 1983, Sweet 1983, Corr and Fogleman 1984, Hayes and Jennings 1986]). Given the possibility of confounding effects, it is important to determine the real factors that influence populations by investigating several possible factors, since association is not necessarily causation. For example, just because red-legged frog numbers are low where bullfrog numbers are high does not prove that bullfrogs are the primary factor regulating the native frog's population; other factors such as the presence of non-native fish or habitat alteration of critical nesting substrate may regulate the frog's population, and bullfrogs may merely be associated with these other factors (Hayes and Jennings 1986).

## 2.2 Avifauna

VAFB is inhabited by a large number of avian species that are of special concern (Table 2). Birds are the least costly to monitor among taxonomic classes of vertebrates (Verner 1983) and are widely used to evaluate environmental impacts. They are useful for the evaluation of impacts, since there are many different species that use different components of habitat type in different ways. Recent studies (Severinghaus 1982, Szaro and Balda 1982, Verner 1983), promote the use of birds in environmental monitoring and impact assessment. Habitat selection in birds is related to measurable features of their

Table 2. Potential avian species of special concern that may occur on VAFB or may be affected by VAFB activities.

Common name	Scientific name	Federal status	State status
Common loon	<i>Gavia immer</i>		
Western grebe	<i>Aechmophorus occidentalis</i>		D
California brown pelican	<i>Pelecanus occidentalis californicus</i>	E	E,D
Double-crested cormorant	<i>Phalacrocorax auritus</i>		D
Fork-tailed storm petrel	<i>Oceanodroma furcata</i>		
Black storm petrel	<i>Oceanodroma melania</i>		
Ashey storm petrel	<i>Oceanodroma homochroa</i>		
American bittern	<i>Botaurus lentiginosus</i>		
Great blue heron	<i>Ardea herodias</i>		D
Great egret	<i>Casmerodius albus</i>		D
Snowy egret	<i>Egretta thula</i>		D
Black-crowned night heron	<i>Ncyticorax nycticorax</i>		D
Green-backed heron	<i>Butorides striatus</i>		
White-faced ibis	<i>Plegadis chihi</i>	C2	D
Turkey vulture	<i>Cathartes aura</i>		
Cooper's hawk	<i>Accipiter cooperi</i>		D
Sharp-shinned hawk	<i>Accipiter striatis</i>		D
Swainson's hawk	<i>Buteo swainsoni</i>	C2	
Ferruginous hawk	<i>Buteo regalis</i>	C2	
Northern harrier	<i>Circus cyaneus</i>		D
Black-shouldered kite	<i>Elanus caeruleus</i>		D
Golden eagle	<i>Aquila chrysaetos</i>		D
Bald eagle	<i>Haliaeetus leucocephalus</i>	E	E,D
Prairie falcon	<i>Falco mexicanus</i>		D
American peregrine falcon	<i>Falco peregrinus anatum</i>	E	E,D

Table 2. (continued)

Common name	Scientific name	Federal status	State status
Merlin	<i>Falco columbarius</i>		
California black rail	<i>Laterallus jamaicensis coturniculus</i>	C2	T,D
Light-footed clapper rail	<i>Rallus longirostris levipes</i>	E	E,D
Common moorhen	<i>Gallinula chloropus</i>		
Greater sandhill crane	<i>Grus canadensis tabida</i>		T,D
Western snowy plover	<i>Charadrius alexandrinus</i>	C2	D
Mountain plover	<i>Charadrius montanus</i>	C2	
Laughing gull	<i>Larus atricilla</i>		D
California gull	<i>Larus californicus</i>		D
California least tern	<i>Sterna antillarum browni</i>	E	E,D
Caspian tern	<i>Sterna caspia</i>		D
Elegant tern	<i>Sterna elegans</i>		D
Black skimmer	<i>Rynchops niger</i>		D
Long-billed curlew	<i>Numenius americanus</i>	C2	
Marbled murrelet	<i>Brachyramphus marmoratus</i>		D
Rhinoceros auklet	<i>Cerorhinca monocerata</i>		D
California yellow-billed cuckoo	<i>Coccyzus americanus occidentalis</i>	C2	D
Short-eared owl	<i>Asio flammeus</i>		D
Long-eared owl	<i>Asio otus</i>		D
Burrowing owl	<i>Athene cunicularia</i>		D
Willow flycatcher	<i>Empidonax traillii</i>		D
Purple martin	<i>Progne subis</i>		D
Bank swallow	<i>Riparia riparia</i>		D
Tree swallow	<i>Tachycineta bicolor</i>		
Chestnut-backed chickadee	<i>Parus rufescens</i>		

Table 2. (continued)

Common name	Scientific name	Federal status	State status
Chestnut-backed chickadee	<i>Parus rufescens</i>		
Swainson's thrush	<i>Catharus ustulatus</i>		
Least bell's vireo	<i>Vireo bellii pusillus</i>	E	E,D
Warbling vireo	<i>Vireo gilvus</i>		
California yellow warbler	<i>Dendroica petechia brewsteri</i>		D
Yellow-breasted chat	<i>Icteria virens</i>		D
Wilson's warbler	<i>Wilsonia pusilla</i>		
Blue grosbeak	<i>Guiraca caerulea</i>		
Belding's savannah sparrow	<i>Passerculus sandwichensis</i>	C2	D
Grasshopper sparrow	<i>Ammodramus savannarum</i>		
Tri-colored blackbird	<i>Agelaius tricolor</i>	C2	D

E=Endangered 50 CFR 17.11 and 17.12

T=Threatened 50 CFR 17.11 and 17.12

C2=Federal candidate species, Category 2 50 CFR 181

D=Special animal, Natural Diversity Data Base, California Fish and Game, 3/85

habitat (Lack 1933, Svardson 1949, Hagar 1960, Martin 1960, MacArthur et al. 1962, Karr 1968, Anderson and Shugart 1974, Wilson 1974). This provides a mechanism to link wildlife data with vegetation to investigate cause and effect relationships. It provides a mechanism to predict and interpret change to the wildlife community from land use practices or other vegetational changes.

Riparian habitat is of great importance to wildlife (Hirsch and Segelquist 1978). Other than destruction of riparian habitat, harmful effects on riparian birds can result from habitat degradation (Gray and Greaves 1985) such as grazing (Coulombe and Cooper 1976, Bohn and Buckhouse 1986, Davis 1986, Taylor and Littlefield 1986, Wagstaff 1986), the cessation of flooding (Engel-Wilson and Ohmart 1978), channelization (Barclay 1978), and cowbird parasitism (Payne 1973, Gaines 1977, Goldwasser 1978, Smith and Atkins 1979, Clark and Robertson 1981, Smith 1981, Hanka 1984, Folkers and Lowther 1985). Riparian habitat on VAFB is inhabited by a number of avian species of special concern for the southern half of California (Remsen 1978, Webster 1980, Tate 1981, Lehman 1982, Tate and Tate 1982, Howald et al. 1985, Breininger 1988). Riparian habitat is generally inhabited by a more diverse and abundant avifauna than surrounding habitat and is often important in maintaining a portion of the avian population in surrounding areas (Szaro and Jakle 1985). Avian composition of riparian habitat on VAFB varies with respect to the size of riparian areas, the proximity to the coastal fog belt, and vegetation structure (Webster 1980, Breininger 1988). Variability is expected since other riparian studies have shown that birds of riparian areas do not all respond to the same habitat features (Best and Stauffer 1980, Anderson et al. 1983, 1984, Layman 1985, Szaro and Jakle 1985, Manuwal 1986).

There is evidence for further deterioration of Barka Slough (Breininger 1988, Schmalzer et al. 1988) since Dial's (1980) report, as would be predicted



based on Hutchinson (1980) and Mallory (1980). Monitoring and management of this system should be undertaken since it is one of the finest riparian areas in the southern half of California (Webster 1980). This system is affected by activities upstream and by pumping from the VAFB well field (Hutchinson 1980, Mallory 1980). A monitoring program should be initiated to investigate relationships between habitat parameters and habitat suitability of riparian species of special concern. Such information not only can be used to monitor the health of riparian areas on VAFB but can also be used to develop procedures to manipulate vegetation to enhance wildlife (Anderson et al. 1983).

Studies should not only consider the breeding season but should also consider winter (Rice et al. 1980, Anderson et al. 1983, Motroni 1985), since there are often seasonal differences in habitat selection within riparian habitat and since riparian areas are also important to migratory birds (Brinson et al. 1981). Food is often superabundant in spring and summer so that birds often select for habitat features on the basis of nesting requirements. However, in winter food is scarce so they may select features on the basis of food availability (Meents et al. 1983). Water in late summer may be important to some birds in coastal central California (Williams and Koenig 1980).

Long-term investigation of habitat suitability is needed because there are potential failures in predicting habitat suitability from one year studies (Wiens and Rotenberry 1981, Van Horne 1983, O'Connor 1986). Determining the habitat importance to the yellow-billed cuckoo must be judged over extended periods because of fluctuations in food supply and because the species does not always nest in the same areas from year to year.

There are other important wetlands associated with major drainages, including the river mouths of the Santa Ynez River and San Antonio Creek. The Santa Ynez estuary is seasonally connected to the Pacific Ocean (Mahrtdt et al.

1976) and has been described as an important area to migratory birds (Coulombe and Cooper 1976, Lehman 1982), but there is little quantitative data of bird use. Some of this estuary is used by the public for recreation, but some recreational activities can be expected to be deleterious to bird populations of the estuary. Unrestricted vehicular traffic can reduce the use of marsh and open water areas by waterfowl. One of the simplest means of habitat improvements is to regulate access to certain areas during times of peak usage (Anderson et al. 1984). Managing recreational activities is important since these sites serve as wintering areas or staging areas for migration. Such areas are essential for successful migration considering the energy demands associated with migration, but the loss of such habitat in the past in California has been alarming (Meyers 1983).

In addition to being important to migratory birds, the Santa Ynez is important to several species of special concern that are or may be local breeders. It is not known what subspecies of savannah sparrow breed in this estuary (Coulombe and Cooper 1976, Webster 1980, Lehman 1982). The subspecies to the north of VAFB is reported as the Bryant savannah sparrow (*Passerculus s. bryanti*) with a southern limit near Morro Bay. The species to the south is the Belding's savannah sparrow (*P.s. beldinghi*) with a northern limit reported as the vicinity of Santa Barbara (Grinnel and Miller 1944). This latter subspecies has been proposed for federal listing. It is reported to nest within vegetation such as *Salicornia* present in the Santa Ynez (Coulombe and Cooper 1976, Mahrtdt et al. 1976).

Another potential species of concern is the clapper rail. The distribution of clapper rails given by Grinnel and Miller (1944) did not suggest that the species was present on VAFB, but Lehman (1982) reports that these authors were apparently unaware of another nearby population in Sandyland Slough in

Carpinteria. The southernmost location for the California clapper rail has been reported as Morro Bay but its subspecific identity is disputed (Gill 1979). The reported northern population of the endangered light-footed clapper rail is south of VAFB in Carpinteria, although there is the possibility of them nesting in Goleta Slough (Zembal and Massey 1981). Clapper rails occupying *Salicornia* marsh can be difficult to census (Zembal and Massey 1987); methods include listening for spontaneous vocalizations near sunset in March, April, and May and nest searches in late May and early June (Zembal and Massey 1981). Another species of special concern that could be at this estuary is the secretive California black rail (Coulombe and Cooper 1976, Coulombe and Mahrtdt 1976, Paul Lehman, pers. comm.).

Brown pelicans are a species of special concern that congregate frequently from Point Pedernales to the boat house, Purisima Point, and other locations (Coulombe and Cooper 1976). Nearby breeding populations of pelicans and other seabirds are located in the Channel Islands; these have received study due to possible effects from sonic booms of space shuttle operations (Dickson 1978, Bowles and Stewart 1980, Cooper and Jehl 1980, Jehl and Cooper 1980). Although the effects of launch operations on the Channel Islands have been investigated, there has been little investigation of possible effects to sea birds that nest on VAFB. Some species such as the pigeon guillemot and rhinoceros auklet nest very near the shuttle launch pad (Lehman 1982). Nesting colonies of the pigeon guillemot on VAFB include Point Sal, Point Pedernales, and Point Arguello. The range of rhinoceros auklets is either changing or is becoming better known. The potential colony at VAFB is near the known border of the species breeding range. The species nests in burrows and is reported to approach nesting areas only under the cover of darkness, limiting documentation of their breeding range (Scott et al. 1974).

They have, however, been observed bringing food to suspected nest sites in some locations during daylight (Scott et al. 1974); this may be influenced by disturbance. Pairs of the marbled murrelet have also been found at Point Sal.

The western snowy plover, found on sandy beaches and river mouths, has decreased as a breeder in Santa Barbara County (Lehman 1982) but is still found nesting on VAFB at areas including Purisima Point and Santa Ynez River mouth. The VAFB population is supplemented by winter visitors. Some birds may winter in areas used for breeding, whereas others may use areas farther south (Warriner et al. 1986). Counts of the species are currently being performed by Mike McElligott in cooperation with the Point Reyes Bird Observatory. A cumulative total of 3409 breeding adults has been found in coastal and interior areas of California (Page and Stenzel 1981). There are fewer birds in coastal areas (Jacobs 1986); densities have been reported by Page et al. (1979), Stenzel et al. (1981), and others. Much of the snowy plover decline has been attributed to increased use of beaches by humans; beach use in important areas should be controlled (Jacobs 1986). Nest success is influenced by predators such as gulls, ravens, crows, and raccoons (Jacobs 1986), adverse weather (Jacobs 1986), and human disturbance (Page et al. 1981, Warriner et al. 1986). Breeding habitats are characterized by flat, open, sandy areas with no or sparse vegetation (Page et al. 1981, Warriner et al. 1986). Chicks will use vegetation as escape cover (Page et al. 1981); this may be an important habitat component (Jacobs 1986). Cover conditions should be assessed on an annual basis and procedures should be used to reduce cover when it exceeds 11 percent or average live vegetation exceeds 1 percent. Removal of the exotic grasses on the foredune may sometimes be necessary to increase the width of coastal habitat (Jacobs 1986). The introduction of vegetation to control the instability of dunes is thought to be detrimental (Wilson

1980). Other species of special concern that frequently use VAFB beaches include the long-billed curlew (Lehman 1982).

Nesting areas of the California least tern at San Antonio Creek and Purisima Point (south) have been protected from human disturbance. Lehman (1982) reported breeding populations along the north coast of Santa Barbara County to be decreasing. The activity of terns has been monitored during Minuteman Missile launch tests and results suggested that there were no adverse impacts to the birds reproductive behavior (Henningson et al. 1981). The suspected major predator of least tern eggs is the Norway rat (Craig 1971), although gulls, coyotes, foxes, and other predators also take eggs. Chick loss has been attributed to predators (Craig 1971, Wilbur 1974) and weather (Wilbur 1974). Predator populations can be affected by land use management.

Different levels of grazing may have beneficial or adverse effects on various species of special concern. Some areas on the southern part of VAFB have been extensively damaged by past cattle grazing practices (Coulombe and Cooper 1976). Several breeding and/or wintering bird species of special concern utilize grazed areas, particularly raptors. Examples include the black-shouldered kite, northern harrier, Swainson's hawk, red-tailed hawks, ferruginous hawks, prairie falcon, and American kestrel. The black-shouldered kite may prefer feeding areas closest to riparian areas and is probably influenced by moisture which affects its key prey items (Warner and Rudd 1975, Pruett-Jones et al. 1980). The burrowing owl requires ground squirrel burrows for roosting and nesting and occurs on VAFB. Another species of concern is the grasshopper sparrow; information is needed to assess its current status and possible decline south of Monterey and Inyo counties. Grasshopper sparrows inhabit extensive grassland with widely scattered bushes such as *Baccharis* or other taller plants for use as perches (Lehman 1982). Reports on VAFB include

sightings near Point Sal and Barka Slough (Lehman 1982), along with a pair sighted July 1987 north of the Santa Ynez River and west of 13th Street (Jim Greaves and Dave Breininger, pers. obs.).

Peregrine falcons were once permanent breeders in coastal areas of Santa Barbara County (Lehman 1982), but now are only visitors. Morro Rock in San Luis Obispo County is a nearby breeding location for the peregrine falcon. Peregrines released from captive breeding programs have been seen using areas near Gaviota Pass and the mouth of Gaviota Creek (Howald et al. 1985). Peregrines have also nested on VAFB (Mike McElligott, pers. comm.). The species is expected to reestablish itself as a breeder on VAFB.

### 2.3 Mammalian Fauna

Several mammalian species of special concern (Table 3) use VAFB or immediate offshore waters; the occurrence of others, primarily smaller mammals, on VAFB is unknown. Almost no data are available for bats on VAFB. A few attempts have been made to locate bats on VAFB but with little success, possibly because of the coastal fog influence (Coulombe and Mahrtdt 1976). Townsend's big-eared bat occurs throughout California but details of its distribution are scanty, and it appears the species has undergone a marked decline (Williams 1986). This bat occupies a variety of communities but is most common in those that are mesic. Known roosting sites in California include caves, mine tunnels, buildings, and other man-made structures (Dalquest 1947, Pearson et al. 1952, Graham 1966). A single human visit can cause the species to abandon the roost (Williams 1986), and females, particularly, roost in colonies that are highly susceptible to disturbance (Barbour and Davis 1969). Roosts should be protected from disturbance where they are known to exist. The subspecies, *Plecotus townsendii pallescens*, characteristic of southern

Table 3. Mammalian species of special concern that may occur on VAFB or may be affected by VAFB activities.

Common name	Scientific name	Federal status	State status
Ornate salt marsh shrew	<i>Sorex ornatus salicornicus</i>	C2	
Townsend's big eared bat	<i>Plecotus townsendii</i>		D
Western mastiff bat	<i>Eumops perotus</i>		D
Big free-tailed bat	<i>Nyctinomops macrotis</i>		D
Southern sea otter	<i>Enhydra lutris nereis</i>	T	D
American badger	<i>Taidea taxus</i>		
Ringtail	<i>Bassariscus astutus</i>		
Mountain lion	<i>Felis concolor</i>		
Gaudalupe fur seal	<i>Arctocephalus townsendii</i>		T,D
Blue whale	<i>Balaenoptera musculus</i>	E	
Finback whale	<i>Balaenoptera physalus</i>	E	
Grey whale	<i>Eschrichtius robustus</i>	E	
Humpback whale	<i>Megaptera novaeangliae</i>	E	
Point Conception kangaroo rat	<i>Dipodomys agilis fuscus</i>		
Western gray squirrel	<i>Sciurus griseus</i>		
Southern marsh harvest mouse	<i>Reithrodontomys megalotis limicola</i>		D

E=Endangered 50 CFR 17.11 and 17.12

T=Threatened 50 CFR 17.11 and 17.12

C2=Federal candidate species, Category 2 50 CFR 181

D=Special animal, Natural Diversity Data Base, California Fish and Game, 3/85

California, is already recognized by the California Department of Fish and Game as a special animal. The subspecies, *P.t. townsendii*, characteristic of central and northern California, occupies humid coastal regions and appears to have undergone a decline in central California (Williams 1986).

The California mastiff bat (*Eumops perotus californicus*) was probably once widespread in coastal lowlands from San Francisco Bay southward to San Diego (Williams 1986), probably favoring rugged, rocky areas with suitable crevices for roosts (Krutzsch 1955, Vaughan 1959). They will also roost in buildings, but these roost sites and suitable natural crevices must allow the bats to drop 2 to 3 m for launching since the bats have great difficulty in taking flight. Williams (1986) recommended surveys to find roost sites and recommended that guano accumulations should be measured for pesticide loading.

The big free-tailed bat is unlikely to occur at VAFB; records of the species in California are extremely rare, and its distribution is poorly understood. Records of the species are from lowlands in southern California except for one confounding specimen from the Berkeley area (Williams 1986). The species is known to occupy relatively rocky areas.

There is a subspecies of kangaroo rat (*Dipodomys agilis fuscus*) that reportedly occurs in coastal chaparral in the general vicinity of Point Conception (Boulware 1943), although Best (1983) found no characteristics that could be used to separate the subspecies from the widely distributed *D.a. perplexus*. Coulombe and Mahrtdt (1976) discussed taxonomic problems associated with kangaroo rats on VAFB. Williams (1986) lists the Point Conception kangaroo rat as a species of special concern but believes further study will not warrant the taxonomic recognition as a separate subspecies.



The western gray squirrel has been listed as a possible species of special concern for VAFB (URS 1987). The species is primarily restricted to the relict Bishop pine forest (Coulombe and Mahrtdt 1976).

The southern salt marsh harvest mouse has been recorded in coastal salt marshes, particularly those dominated by *Salicornia*, north to Santa Barbara County in the Carpinteria salt marsh. If found on VAFB, it would represent a northern range extension of its known distribution.

The sea otter population of California has been estimated at 1800 individuals or less (Woodhouse et al. 1977, U.S. Fish and Wildlife Service 1982). The central California population has made a dramatic recovery from the relict population of approximately 50 individuals off the Monterey County coast since it has been protected, but the population is still threatened in the event of a major oil spill. The translocation of enough animals to establish a second colony was recommended to reduce the vulnerability of the population (Ralls and Ballou 1983), and such relocation has been recently performed. The current range of the main population (excluding recent relocation attempts) now extends south to San Luis Obispo County (Wild and Ames 1974). Numerous sightings of a few individuals have occurred on VAFB (Crisologo 1984, Charles Pergler, pers. comm.), but these do not constitute anything near a sustainable population at this time. Sea otters in central California prey on a variety of invertebrates (Ebert 1968, Wild and Ames 1974, Stephenson 1977, Hines and Loughlin 1980, Wendell et al. 1986) and undergo prey switching, depending on the abundance of preferred food items (Ostfeld 1982). Knowledge of predator-prey interactions of sea otters in California has come primarily from "before-and-after" studies as the otter has begun to reoccupy its former range (Hines and Pearse 1982). Otters play key ecological roles in kelp bed communities, particularly because they control sea urchin grazing on kelp thereby allowing

the development of a luxuriant macroalgae community (Estes and Palmisano 1974, Duggins 1980). The species has had a profound impact on the abundance of other herbivores including commercial and recreational species such as abalones (Ebert 1968, Wild and Ames 1974), red crab (Miller 1974), rock crab (Wendall et al. 1986), dungeness crab (Matkin 1981, Kimker 1982), and pismo clams (Stephenson 1977, Wendell et al. 1986). Otters are blamed for the loss of particular fisheries, and once otters are established it is unlikely that a return of lost fisheries will occur (Wendell et al. 1986). Therefore, any continued reoccupation of their former range will be controversial, since it is likely to be unpopular with many fishermen. One can expect that VAFB will be reoccupied by a sustainable population if the otter is given continued protection. The rapid and predictable influence of sea otters as keystone predators requires careful management of otter populations due to its widespread implications (Duggins 1980). It would be worthwhile to maintain records of all otter sightings on VAFB.

The badger has been reported as a reasonably widespread carnivore in Santa Barbara County and as declining in south coastal areas (Howald et al. 1985), but such reports lack quantitative supportive data. Badgers have been poisoned, trapped, or have succumbed to agricultural practices (Williams 1986); their numbers were reduced over almost all of their range in California by 1932 (Grinnel et al. 1937). The species occupies a variety of habitats, feeding mostly on rodents including ground squirrels. Coulombe and Mahrtdt (1976) reported that badgers are uncommon on VAFB. They now appear to be more common on VAFB.

Ringtail are typically found in areas with rocky, brush covered hillsides near rivers in habitat types such as oak woodland and riparian forest (Orloff 1976). Because it is a secretive nocturnal animal, it is seldom seen so that all

records of sightings are important to the California Department of Fish and Game.

There is considerable habitat in the general vicinity of VAFB for wide ranging species like mountain lions, bobcats, and black bears. Coulombe and Mahrtdt (1976) suggested a large population of bobcats occur on VAFB, particularly in canyons of riparian woodland. Mountain lions seem to occur regularly in the western end of the Santa Ynez Mountains occasionally ranging into south VAFB (Howald et al. 1985). Suitable habitat appears to occur there (Howald et al. 1985). Their preferred habitat seems to be steep, inaccessible slopes with dense cover of chaparral (Koford 1978). Basic habitat requirements for mountain lions include low human density, high prey density, and appropriate cover conditions. Wide ranging large carnivores have often been eliminated or greatly reduced in fragmented systems (Noss and Harris 1986). These species often link together ecosystem components and may have played a keystone role in determining the composition and diversity of ecological systems (Hansson 1977, Noss and Harris 1986).

Several haulout areas for pinnipeds, particularly harbour seals and the California sea lion, have been identified on VAFB. These areas fall under the jurisdiction of the Marine Mammal Protection Act of 1972. The two most commonly used areas are at Point Sal and Point Arquello, although other areas in the vicinity include Purisima Point, Rocky Point, and Sudden Ranch. Concerns about disturbance impacts to harbour seals have previously been expressed (Crisologo 1984). Other pinnipeds that may occasionally use waters in the vicinity of VAFB include the northern elephant seal, Stellar's sea lion, and the Guadalupe fur seal (Jones and Stokes Associates, Inc. 1981). Pinnipeds have an aesthetic and recreational value. Haulout areas need to be mapped and activities should be regulated in such areas.

Several other mammalian species, whose populations have declined, include the whales that can be found near the coast (Table 3). Other species of whales use waters farther offshore from VAFB (Jones and Stokes Associates, Inc. 1981). Although whales do not use the land resources off VAFB, there could be some Air Force activities or activities permitted by the Air Force that might be considered in the environmental assessment process.

Development of management plans for the deer herd at VAFB is limited by a lack of studies performed in habitats near VAFB. Mule deer in the high coastal mountains of California, the Sierra Nevada, and the Great Basin have distinct seasonal migrations, but herds in much of the south and central coastal areas of California lack distinct seasonal migration (Dasmann and Taber 1956, Longhurst et al. 1982). There can still be important differences in habitat use pertaining to summer and winter home ranges in areas without major movements between summer and winter range.

It may be necessary to emphasize certain areas of the base for the investigation of habitat use. Fawns from oak woodland have been shown to be in better physical condition than fawns from chaparral (Mansfield et al. 1975). Different types of chaparral may result in differences in herd production due to differences in vegetational aspects (Taber 1953). Acorn production can significantly affect herd production in areas that are predominately chaparral, especially with respect to survival of fawns through the critical summer months and survival and breeding conditions of does for the following years fawn production (Ashcraft 1979). Acorn production can vary dramatically, spatially, and from year to year, but almost no information is available to assess this variation for VAFB. Coulombe and Cooper (1976) noted responses of the base herd to yearly variation in rainfall when analyzing hunting statistics (which can be found in Naydol 1986). Some animal populations are regulated by

ecological crunches that occur in bad years (Wiens 1977) where only a portion of the population survives in certain areas (O'Connor 1986). In contrast, some populations are regulated by a short favorable period in good years that allows sufficient reproduction to sustain the population (Holmes et al. 1986).

Riparian vegetation provides key foraging sites for California mule deer during hot summer months; in chaparral areas, it represents the core of chaparral deer populations (Dasmann and Taber 1956, Ashcraft 1979). The availability of water is a major factor associated with regulating the distribution of fawning areas (Bowyer 1986). Cover is also a very important parameter and is essential for the fawning period (Taber and Dasmann 1958, Welker 1986). Sexual segregation of habitat use and differences in water needs can occur (Bowyer 1984).

Habitat management includes range management, since cattle can limit deer populations by direct competition for food and by damaging vegetation for cover (Bowyer and Bleich 1984). Both forage and cover must be considered in management (Scotter 1980). Fire dramatically influences the quality and quantity of browse in chaparral (Gogan et al. 1986). Manipulation of chaparral whether by fire or mechanical means can be used to benefit mule deer (Biswell et al. 1952, Taber 1953, Taber and Dasmann 1958); however, specific manipulations must take into account specific habitat requirements (Holecheck et al. 1982b, Bowyer 1986). Important considerations for fire management are that deer prefer to feed within 300 feet of cover. There is a shortage of cover and food, except along edges, immediately after burning (Ashcraft 1979). This shortage is often of a short duration and is soon followed by improved forage and the reestablishment of cover. Ashcraft (1979) recommended periodic burning (2-3 years) of small parcels (2-5 acres) to maintain life requisites. Best management practices may vary with the type of chaparral, since different sites

or types of chaparral may have different responses. Development of fire management plans must consider other ecological factors (Hickson 1987, 1988, Schmalzer et al. 1988) and practicality. Quantification of home range habitat characteristics can be used to provide a range of suitable management practices. Small fires may allow small herbivores from unburned areas to exploit seedlings of sprouting Burton Mesa chaparral plants (Frank Davis, pers. comm.) so that the composition of a community after fire may be affected by the size and intensity of the burn. Mills (1986) suggested the prevalence of the *Ceanothus* in a site may be a function of the size of the previous burn due to herbivores preferring to forage near cover.

Suggestions have been made to evaluate the diet of deer on VAFB, which would enhance the understanding of limiting factors affecting deer herds. Deer production and habitat use are influenced by the quality of food. Crude protein is one of the most important nutritional indices to consider in evaluating deer browse in California deer (Taber 1953). Spring is a time of abundant and nutritious forage, since it is when shrubs begin their annual growth and are of high value. Herbaceous plants can also be abundant and succulent, particularly on burned and open shrublands (Ashcraft 1979). In late summer the quality of food, especially crude protein, drops as forage matures. During this time the moisture content of food is low and deer often need water to drink (Taber 1953). The importance of knowing water and summer and range conditions for deer herd management can not be underestimated (Bauer et al. 1986). Seasonal changes in diet have been demonstrated (Betram and Rempel 1977), so that diet analysis studies on VAFB will need careful consideration of objectives. Analysis of food actually consumed can include a variety of methods including direct observation, stomach analysis, fecal analysis, and fistula techniques, all having important limitations (Holecheck et

al. 1982a). Errors can occur without careful quality control in microhistological techniques (Holecheck and Gross 1982). Errors can also result in extrapolating from a few samples to a population (Westoby et al. 1976).

Other important questions include a knowledge of the size of the deer herd and where they occur in the highest densities. Methods to investigate this include spotlight surveys at night (Mitchell 1986a), pellet group surveys (Eberhardt and Van Elten 1956), and aerial surveys. Track count methods may be the most suitable technique in heavily wooded areas but require proper moisture and texture to maintain track imprints (Mitchell 1986b). Aerial surveys can be useful since they can quickly cover large areas. Helicopters overcome many difficulties associated with fixed wing aircraft since speed and altitude can be altered more easily (Beasom et al. 1981). Bartmann et al. (1986) tested the accuracy of helicopter aerial surveys and reported that 2/3 seemed like the maximum fraction of mule deer that can be seen from a helicopter in Pinyon-Juniper winter range. Prior to selection of methods, it would be good to determine, based on habitat conditions, which areas might vary most with respect to habitat suitability based on food, cover, and water requirements. It may be desirable to develop information to allow management to reduce habitat suitability in areas where deer/man conflicts may occur and improve areas away from operational areas. Fencing watering areas or fencing to funnel deer between areas of preferred habitat could be used to minimize conflicts (Coulombe and Cooper 1976).

The health of the herd is always an important consideration, much of the data needed to determine herd health can be derived from that taken from analysis of hunting, since these data can be readily obtained and methods have been developed to utilize such data. Consideration of inherent assumptions is needed; however, since there can be limitations associated with the evaluation

of the ages of deer (Erickson et al. 1970) and the use of age ratios to reflect population dynamics (Caughley 1974). Road-killed deer can also serve as an important tool in the inventory and management of deer herds (Salwasser et al. 1980).

Feral hog populations can have negative influences on vegetation (Ralph and Maxwell 1984), herpetofauna, and ground nesting birds (Wood and Barrett 1979), small mammals (Singer et al. 1984), agricultural fields, and livestock watering facilities. Coulombe and Cooper (1976), Dial (1980), Webster (1980), and Naydol (1986) reported their destructiveness within riparian areas on VAFB, recommending control of their populations. It may be impossible to eradicate hogs, but they will need to be controlled since they are capable of becoming a serious problem. Control should be achievable, since studies have shown that hog populations can be reduced by a sustained take. Understanding their habits on VAFB using telemetry and other habitat use studies could be used to enhance control of the species. Fecal counts have been used to study habitat use (Ralph and Maxwell 1984), as well as other signs of hog activity (Antonelli 1979).

Activity and distribution of hogs is influenced by weather and food (Antonelli 1979, Van Vuren 1984). Poffenberger (1979) found temperature to be an important factor affecting hog activities and that keeping cool was important for habitat selection during warmer months. On Santa Cruz Island, pigs have been found to be active in mornings and evenings during fall and spring and midday during the winter (Van Vuren 1984). Newborn pigs at birth are highly susceptible to cold (Mount 1968). These characteristics are all related to pigs having poor physiological thermoregulation.

Most wild hogs in California occur in oak woodlands or chaparral habitats (McKnight 1964). This may, however, be related to the total amount of various



habitat types available and not altogether to preference. On VAFB, there are several large riparian areas where hogs are believed to be most common. Pine and Gerdes (1973) reported pigs in California are found near or in creek bottoms during the dry season but are not dependent on permanent water in winter and spring. Mast, particularly acorns, is the single most important food of wild pigs in California (Pine and Gerdes 1973). During the winter wet season, pigs use green forage, roots, underground bulbs, and soil invertebrates (Barrett and Pine 1980). Declines of hogs probably occur during years of drought and acorn crop failure (Barrett and Pine 1980). Pigs in coastal central California farrow year around, but most farrowing occurs from October to June (Pines and Gerdes 1973). Cover is important to hogs, and in particular, dense cover is needed for farrowing sites. The primary social unit for hogs is a mother and young bond (Baber 1977). Feral hogs have been found to occupy non-exclusive home ranges where several social units may inhabit one particular area (Baber 1977). Young hogs are very dependent on their mother (Strand 1980). Safe control of hogs involves hunting and trapping. O'Brien et al. (1986) found that sodium monoflouracetate (1080) when used to control feral pigs frequently causes vomiting, and the vomitus is hazardous to a variety of non-target species.

Some areas on VAFB have high California ground squirrel populations (Coulombe and Mahrdt 1976). Ground squirrels are reported to degrade land and building foundations, decrease productivity, and produce costly damage to agricultural equipment. The poison 1080 has been used to control ground squirrels elsewhere but has been shown to result in secondary mortality to rabbits and mammalian predators (Hegdal et al. 1986). Recently, raptor perches have been built at VAFB in the hope of controlling ground squirrels (Mike McElligott, pers. comm.). Janes (1984) found that long-term reproductive

success of red-tailed hawks was primarily correlated with the dispersion and density of perches and secondarily with the abundance of ground squirrels. He suggested that hawks in territories with few or poorly dispersed perches deplete prey near the perches that are present.

Another potential pest species is the beaver which was introduced to VAFB. The beaver modifies creeks in such a way that they could become unsuitable to unarmored three spine sticklebacks especially if they stop the flow of water (Irwin and Soltz 1982). Feral cats have also been reported on VAFB (Coulombe and Mahrtdt 1976). Small mammal and avian communities can be affected by introduced rats, mice, and birds that compete with native fauna and also by others such as feral cats that predate upon native fauna.

### 3.0 Conclusions

1) There are 29 federally listed species (endangered, threatened, or Category 2) that occur or may occur on VAFB. There are also 63 other state-listed or other regionally declining species that may use areas on VAFB. Many of these can be expected to be listed or be proposed for listing. Species of special concern that are not yet federally listed are excellent indicators of environmental quality. Management of such species before their existence is endangered could prevent their decline thereby minimizing future conflicts with operations.

2) There have been many environmental assessments and environmental impact studies performed for energy development or for Air Force programs; yet few have involved field investigations that produce quantifiable data for understanding the ecology of VAFB.

3) The establishment of a base has promoted the protection of large amounts of land not directly used by Air Force programs. Given all the energy

development activities and off-base water use from drainages flowing into VAFB, there will be confounding influences in determining whether the Air Force is or is not managing the VAFB natural environment properly without investigations that provide quantifiable data on the ecology of the area.

#### **4.0 Recommendations**

There is a need to develop an institutional commitment to wildlife monitoring on VAFB, establishing a reliable and continuous funding source. Data collection should be scientifically valid to provide credibility to the monitoring program; periodic outside review should be conducted. Below are some preliminary, specific recommendations.

1) Review scientific literature on faunal species, particularly species of special concern to: a) summarize known wildlife/habitat relationships and determine information needs, and b) establish what species are partly dependent on VAFB for their maintenance in the region of California that includes VAFB.

2) Establish study stations in most areas that have riparian habitat and survey birds and habitat features to develop a preliminary model relating habitat parameters to the abundance of riparian bird species of special concern. Use the results to develop management recommendations, to define the importance of different riparian areas, and to develop a long-term monitoring plan. Assess the needs to manage areas adjacent to riparian habitat.

3) Determine the location and seasonal use of avian resources, particularly migratory and other species of special concern, within the Santa Ynez estuary. Use results to develop a plan for management of public recreation and long-term monitoring.

4) Determine the status of amphibian and reptilian species of special concern, map their critical habitats, and develop a management and monitoring strategy.

5) Monitor seabird colonies on base.

6) Determine species of special concern that use grazed areas; review literature on habitat requirements to determine any special needs for range management. Characterize and map grasshopper sparrow breeding areas, determine if other populations exist, and monitor their population.

7) Maintain records of peregrine falcon sitings. Determine potential nesting locations based on detailed review of literature, map such locations, and restrict human disturbance in the area.

8) Keep performing snowy plover surveys and assessing the significance of the least tern population. Assess whether management actions are needed in the nesting area.

9) Determine whether raptor perches are valuable for controlling ground squirrels on VAFB.

10) Continue or expand control of the feral pig and assess feral pig damage. A study of life history could enable better control.

11) More information on the life history of the mule deer, particularly movements, should be gathered to improve herd management and prevent deer/human conflicts. Specific objectives will need to be formulated, and investigations may need to focus on specific areas of the base.

12) Map pinniped haulout areas, investigate seasonality of use, and develop a plan to minimize disturbance.

13) Maintain records of sightings of ringtails, sea otters, mountain lions, and black bears.

## 5.0 Literature Cited

- Anderson, B.W., R.D. Ohmart, J.K. Meents, and W.C. Hunter. 1984. Avian use of marshes on the lower Colorado River. Pp. 598-604. In: Warner, E.E. and K.M. Hendrix (eds.). California riparian systems: ecology, conservation, and productive management. University of California Press, Berkeley.
- Anderson, B.W., R.D. Ohmart, and J. Rice. 1983. Avian and vegetation community structure and their seasonal relationships in the lower Colorado River Valley. Condor 85:392-405.
- Anderson, S.H. 1981. Correlating habitat variables and birds. Studies in Avian Biology 6:538-542.
- Anderson, S.H. and H.H. Shugart. 1974. Habitat selection of breeding birds in an east Tennessee deciduous forest. Ecology 55:828-837.
- Andrewartha, H.G. and C.C. Birch. 1954. The distribution and abundance of animals. University Chicago Press, Chicago. 782pp.
- Antonelli, D.S. 1979. Population structure and habitat use of the feral hog (*Sus scrofa*) on Merritt Island National Wildlife Refuge, Florida. Master's Thesis. Florida Institute of Technology, Melbourne. 61pp.
- Ashcraft, G.C. 1979. Effects of fire on deer in chaparral. Cal-Neva Wildl. Trans. 1979:177-189.
- Baber, D.W. 1977. Social organization and behavior in the feral hog. Master's Thesis. Florida Institute of Technology, Melbourne. 66pp.
- Barbour, R.W. and W.H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington. 286pp.
- Barclay, J.S. 1978. The effects of channelization on riparian vegetation and wildlife in south central Oklahoma. Pp. 129-138. In: Strategies for

- protection and management of floodplains, wetlands and other riparian ecosystems. U.S. Forest Service GTR WO-12, Washington, D.C.
- Barrett, R.H. and D.S. Pine. 1980. History and status of wild pigs, *Sus scrofa* in San Benito County, California. *California Fish and Game* 67:105-117.
- Bartmann, R.M., L.H. Carpenter, R.A. Garrott, and D.C. Bowden. 1986. Accuracy of helicopter counts of mule deer in pinyon-juniper woodland. *Wildlife Society Bulletin* 14:356-363.
- Bauer, R.D., J.T. Light, Jr., and W.R. Thorton. 1986. Determination of the winter range of a black-tailed deer herd in the north coast range of California. *California Fish and Game* 54:27-32.
- Beasom, S.L., J.C. Hood, and J.R. Cain. 1981. The effect of strip width on helicopter censusing of deer. *Journal of Range Management* 34:36-37.
- Bertram, R.C. and R.D. Rempel. 1977. Migration of the north kings deer herd. *California Fish and Game* 63:157-179.
- Best, L.B. and D.F. Stauffer. 1980. Factors affecting nesting success in riparian bird communities. *Condor* 82:149-158.
- Best, T.L. 1983. Intraspecific variation in the agile kangaroo rat (*Dipodomys agilis*). *Journal of Mammalogy* 69:426-436.
- Biswell, H.H., R.D. Taber, D.W. Hedrick, and A.M. Schultz. 1952. Management of chamise brush for deer range improvement. *California Fish and Game* 47:125-144.
- Bohn, C.C. and J.C. Buckhouse. 1986. Effects of grazing management on streambanks. *Transactions of the North American Wildlife and Natural Resources Conference* 51:265-271.
- Boulware, J.T. 1943. The new subspecies of kangaroo rats (genus *D. podomys*) from southern California. *University California Publications in Zoology* 46:391-396.

- Bowles, A. and B.S. Stewart. 1980. Disturbances to the pinnipeds and birds of San Miguel Island, 1979-1980. Pp. 99-138. In: J.R. Jehl, Jr., and C.R. Cooper (eds.). Potential effects of space shuttle sonic booms on the biota and geology of the California channel islands: research reports. TR80-1. San Diego State University.
- Bowyer, R.T. 1984. Sexual segregation in the southern mule deer. *Journal of Mammalogy* 65:410-417.
- Bowyer, R.T. 1986. Habitat selection by southern mule deer. *California Fish and Game* 72:153-169.
- Bowyer, R.T. and V.C. Bleich. 1984. Effects of cattle grazing on selected habitats of southern mule deer. *California Fish and Game* 70:240-247.
- Bradford, D. 1983. Winterkill, oxygen relations, and energy metabolism of a submerged dormant amphibian, *Rana mucosa*. *Ecology* 64:1171-1183.
- Breining, D.R. 1988. Survey for least bell's vireo in riparian habitat on Vandenberg Air Force Base, Santa Barbara County, California. NASA Technical Memorandum 100984.
- Brinson, M.M., B.L. Swift, R.C. Plantico, and J.S. Barclay. 1981. Riparian ecosystems: their ecology and status. FWS/OBS-81/17.
- Bury, R.B. and R.A. Luckenbach. 1976. Introduced amphibians and reptiles in California. *Biological Conservation* 10:1-14.
- Caughley, G. 1974. Bias in aerial survey. *Journal of Wildlife Management* 38:921-933.
- Clark, K.L. and R.J. Robertson. 1981. Cowbird parasitism and evolution of anti-parasite strategies in the yellow warbler. *Wilson Bulletin* 93:249-258.
- Cooper, C.F. and J.R. Jehl, Jr. 1980. Potential effects of space shuttle sonic booms on the biota and geology of the California Channel Islands: synthesis of research and recommendations. Center for Marine Studies,

- San Diego State University. Prepared for U.S. Air Force Space and Missile Systems Organization. Technical Report 80-2.
- Corr, P.S. and J.C. Fogleman. 1984. Extinction of montane populations of the northern leopard frog (*Rana pipiens*) in Colorado. *Journal of Herpetology* 18:147-152.
- Coulombe, H.N. and C.F. Cooper. 1976. Ecological assessment of Vandenberg Air Force Base, California. Vol I. Evaluation and recommendations. AFCEC TR-76-15. Air Force Civil Engineering Center. Tyndall Air Force Base, Florida. 187pp.
- Coulombe, H.N. and C.R. Mahrtdt. 1976. Ecological assessment of Vandenberg Air Force Base, California. Vol. II. Biological inventory 1974/75. AFCEC-TR-76-15. Air Force Civil Engineering Center. Tyndall Air Force Base, Florida. 199pp.
- Craig, A.M. 1971. Survey of California least tern nesting sites. California Department of Fish and Game, Special Wildlife Investigations, Project W-54-R-4, Final Report. Job 11-51, 7pp plus appendix.
- Crisologo, R.S. 1984. Environmental surveillance report, no. 19 TOR 040. The Ralph M. Parsons Company, Pasadena, California.
- Dalquest, W.W. 1947. Notes on the natural history of bats *Corynorhinus rafinesquii* in California. *Journal of Mammalogy* 28:17-30.
- Dasmann, R.F. and R.D. Taber. 1956. Behavior of Columbian black-tailed deer with reference to population ecology. *Journal of Mammalogy* 37(2):143-164.
- Davis, J.W. 1986. Options for managing livestock and riparian habitats. *Transactions of the North American Wildlife and Natural Resources Conference* 55:290-297.



- Dial, K.P. 1980. Barka Slough - resources inventory and management recommendations. U.S. Fish and Wildlife Services, Division of Ecological Services, Laguna Niguel, California. 121pp.
- Diamond, J.M. 1975. The island dilemma: lessons of modern biogeographic studies for the design of natural preserves. *Biological Conservation* 7:129-146.
- Dickson, D. 1978. Brown pelican threat to space shuttle. *Nature* 274:304.
- Duggins, D.O. 1980. Kelp beds and sea otters: an experimental approach. *Ecology* 61:447-453.
- Eberhardt, L., and R.C. Van Elten. 1956. Evaluation of the pellet-group count as a deer census method. *Journal of Wildlife Management* 20:70-74.
- Ebert, T.A. 1968. Growth rates of the sea urchin *Strongylocentrotus purpuratus* related to food availability and spine abrasion. *Ecology* 4:1075-1091.
- Engel-Wilson, R.W. and R.D. Ohmart. 1978. Flora and attendant faunal changes on the lower Rio Grande between Fort Quitman and Presidio, Texas. Pp. 139-147. In: *Strategies for protection and management of floodplain wetlands and other riparian ecosystems*. U.S. Forest Service GTR WO-12. Washington, D.C.
- Erickson, J.A., A.E. Anderson, D.E. Medin, and D.C. Bowden. 1970. Estimating ages of mule deer-an evaluation of technique accuracy. *Journal of Wildlife Management* 34:523-531.
- Estes, J.A. and J.F. Palmisano. 1974. Sea otters: their role in structure of nearshore communities. *Science* 185:1058-1060.
- Farmer, A.H., M.J. Armbruster, J.W. Ferrel, and R.L. Schroeder. 1982. Habitat models for land use planning: assumptions and strategies for

- development. Transactions of the North American Wildlife and Natural Resources Conference 87:47-57.
- Fitch, H.S. 1938. *Rana boylei* in Oregon. Copeia 1938:148.
- Flather, C. and T. Hoekstra. 1985. Evaluating population-habitat models using ecological theory. Wildlife Society Bulletin 13:121-130.
- Flood, B.S., M.E. Sangster, R.D. Sparrowe, and T.S. Baskett. 1977. A handbook for habitat evaluation procedures. USDA Fish and Wildlife Services Resource Publication 132, Washington, D.C.
- Folkers, K.L. and P.E. Lowther. 1985. Responses of nesting red-winged blackbirds and yellow warblers to brown-headed cowbirds. Journal of Field Ornithology 56:175-177.
- Fritz, R.S. 1979. Consequences of insular population structure: distribution and extinction of spruce grouse (*Canachites canadensis*) populations. Oecologia 42:57-66.
- Gaines, D. 1977. The status of selected riparian forest birds in California. Unpublished report to California Department of Fish and Game. 56pp.
- Garland, T. and W.G. Bradley. 1984. Effects of a highway on Mojave Desert rodent populations. American Midland Naturalist 111:47-56.
- Gill, R., Jr. 1979. Status and distribution of the California clapper rail (*Rallus longirostris obsoletes*). California Fish and Game 65:36-49.
- Gill, D.E., K.A. Berven, and B.A. Mock. 1983. The environmental component to evolutionary biology. Pp. 1-36. In: C.E. King and P.S. Dawson (eds.). Population biology retrospect and prospect. Columbia University Press, New York.
- Gogan, P.J., S.C. Thompson, W. Pierce, and R.H. Barrett. 1986. Line-transect censuses of fallow and black-tailed deer on the Point Reyes Peninsula. California Fish and Game 72:47-61.

- Goldwasser, S. 1978. Distribution, reproductive success and impact of nest parasitism by brown-headed cowbirds on least bell's vireos. California Department of Fish and Game. Nongame Wildlife Investigations Job IV-1.5.1. 27pp.
- Graham, R.E. 1966. Observations on the roosting habits of the big-eared bat, *Plecotus townsendii* in California limestone caves. Cave Notes 8:17-22.
- Gray, M.V. and J.M. Greaves. 1985. Riparian forest as habitat for the least bell's vireo. Pp. 605-611. In: R.E. Warner and K.M. Hendrix (eds.). California riparian systems ecology, conservation and productive management. University of California Press, Berkeley. 1035pp.
- Gregory, P.T. 1979. Predator avoidance behavior of the red-legged frog (*Rana aurora*). Herpetologica 35:175-184.
- Grinnel, J. and A.H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna 27. 608pp.
- Grinnel, J., J. Dixon, and V. Linsdale. 1937. Fur-bearing mammals of California. Their natural history, systematic status, and relations to man. University of California Press, Berkeley. 1:1-375, 2:376-777.
- Hagar, D.C. 1960. The interrelationships of logging, birds, and timber regeneration in the Douglas-Fir region of northwestern California. Ecology 41:116-125.
- Halvorson, C.H. 1984. Long-term monitoring of small vertebrates: a review with suggestions. Pp. 11-25. In: J.L. Johnson, J.F. Franklin, and R.G. Krebell (eds.). Research natural areas: baseline monitoring and management: proceedings of a symposium. U.S. Forest Service, GTR-INT-173. Intermountain Forest and Range Experiment Station, Ogden, Utah.

- Hammerson, G.A. 1982. Bullfrog eliminating leopard frogs in Colorado?  
Herpetological Review 13:1152-1161.
- Hanka, L.R. 1984. A brown-headed cowbird parasitizes northern orioles.  
Western Birds 15:33-34.
- Hansson, L. 1977. Landscape ecology and stability of populations. Landscape  
Planning 4:85-93.
- Hawkes, C.L., D.E. Chalk, T.W. Hoekstra, and C.H. Flather. 1983. Prediction of  
wildlife and fish resources for national assessments and appraisals.  
USDA Forest Service General Technical Report RM-100, 21 pp. Rocky  
Mountain Forest and Range Experiment Station, Fort Collins, CO.
- Hayes, M.P. and M.R. Jennings. 1986. Decline of ranid frog species in western  
north America: are bullfrogs (*Rana catesbeiana*) responsible? Journal of  
Herpetology 20:490-509.
- Hegdal, P.L., K.A. Fagerstone, T.A. Gatz, J.F. Glahn, and G.H. Matschke. 1986.  
Hazards of wildlife associated with 1080 baiting for California ground  
squirrels. Wildlife Society Bulletin. 14:11-21.
- Henningson, Durham, & Richardson. 1981. Effects of Minuteman launch on  
California least tern nesting activity, Vandenberg AFB, California.  
Henningson, Durham & Richardson, Santa Barbara, California. 23 pp.
- Hickson, D.E. 1987. The role of fire and soil in the dynamics of Burton Mesa  
chaparral, Santa Barbara County, California. Master's Thesis, University  
of California, Santa Barbara. 83pp.
- Hickson, D.E. 1988. History of wildland fires on Vandenberg Air Force Base,  
California. NASA Technical Memorandum 100983.
- Hines, A. and T. Loughlin. 1980. Observations of sea otters digging for clams at  
Monterey Harbor, California. U.S. Marine Fisheries Service Fisheries  
Bulletin 70:159-163.

- Hines, A.H. and J.S. Pearse. 1982. Abalones, shells, and sea otters: dynamics of prey populations in central California. *Ecology* 63:547-560.
- Hirsch, A., W.B. Krohn, D.L. Schweitzer, and C.H. Thomas. 1979. Trends and needs in federal inventories of wildlife habitat. *Transactions of the North American Wildlife and Natural Resources Conference* 44:341-358.
- Hirsch, A. and C.A. Segelquist. 1978. Position paper: protection and management of riparian ecosystems: activities and view of the U.S. Fish and Wildlife Service. Pp. 344-352. In: R.R. Johnson and J.F. McCormick, (tech. coord.). *Strategies for protection and management of floodplain wetlands and other riparian ecosystems*. U.S. Forest Service General Technical Report WO-12. Washington, D.C.
- Hirst, S.M. 1983. Ecological and institutional bases for long-term monitoring of fish and wildlife populations. Pp. 175-178. In: J.F. Beel and T. Atterbury (eds.). *Renewable resource inventories for monitoring changes and trends: proceedings of an international conference*. Oregon State University. Corvallis.
- Holecheck, J.L. and B. Gross. 1982. Evaluation of different calculation procedures for microhistological analysis. *Journal of Range Management* 35:721-723.
- Holecheck, J.L., B. Gross, S.M. Dabo, and T. Stephenson. 1982a. Effects of sample preparation growth stage and observer of microhistological analysis of herbivore diets. *Journal of Wildlife Management* 46:502-505.
- Holecheck, J.L., R. Valdez, S.D. Schemnitz, R.D. Pieper, and C.A. Davis. 1982b. Manipulation of grazing to improve or maintain wildlife habitat. *Wildlife Society Bulletin* 10:204-210.

- Holmes, R.T., T.W. Sherry, and F.W. Sturges. 1986. Bird community dynamics in a temperate deciduous forest: long-term trends at Hubbard Brook. *Ecological Monographs* 56:201-220.
- Howald, A., P. Collins, S. Cooper, W. Ferren, Jr., P. Lehman, K. Saterson, and K. Steele. 1985. Union Oil Project/Exxon Project Shamrock and central Santa Maria basin area study EIS/EIR. Technical Appendix F. Terrestrial and freshwater biology. Arthur D. Little, Inc., Santa Barbara, California.
- Hutchinson, C.B. 1980. Appraisal of groundwater in the San Antonio Creek Valley, Santa Barbara County, California. U.S. Geological Survey Water Resources Investigations Open File Report 80-750.
- Irwin, J.R. and D.L. Soltz. 1982. The distribution and natural history of the unarmored threespine stickleback, *Gasterosteus aculeatus williamsoni* (Girard), in San Antonio Creek, California. Department of Biology, California State University, Los Angeles. U.S. Fish and Wildlife Service Contract No. 11310-0289-80.
- Jacobs, R.A. (Wilson). 1986. Snowy plover (*Charadrius alexandrinus*): section 4.4.1, U.S. Army Corps of Engineers Wildlife Resources Management Manual. Technical Report EL-86-54, prepared by the U.S. Army Engineer District, Portland, Oregon, for the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.
- Jarvinen, O. and R.A. Vaisunen. 1979. Changes in bird populations as criteria of environmental changes. *Holarctic Ecology* 2:75-80.
- Janes, S.W. 1984. Influences of territory composition and interspecific competition on red-tailed hawk reproductive success. *Ecology* 65:862-870.

- Jehl, J.R., Jr. and C.R. Cooper (eds.). 1980. Potential effects of space shuttle sonic booms on the biota and geology of the California Channel Islands: research reports, TR-80-1. San Diego State University. 246pp.
- Jennings, M.R. and M.P. Hayes. 1985. Pre-1900 overharvest of California red-legged frogs (*Rana aurora draytonii*): the inducement for bullfrog (*Rana catesbeiana*) introduction. *Herpetologica* 41:94-103.
- Johnson, R.A. 1981. Application of the guild concept to environmental impact analysis of terrestrial vegetation. *Journal of Environmental Management* 13:205-222.
- Jones and Stokes Associates, Inc. 1981. Ecological characterization of the central and northern California coastal region. Vol. II, Part 2, Species. U.S. Fish and Wildlife Service FWS/OBS-80/46.2.
- Karr, J.R. 1968. Habitat and avian diversity on strip-mined lands in east-central Illinois. *Condor* 70:348-357.
- Karr, J.R. 1987. Biological monitoring and environmental assessment: a conceptual framework. *Environmental Management* 11:249-256.
- Karr, J.R. and D.R. Dudley. 1981. Ecological perspective on water quality goals. *Environmental Management* 5:55-68.
- Kimker, A. 1982. Shell fish report to the Alaska board of fisheries. Department of Fish and Game. 9pp.
- Koford, C.B. 1978. The welfare of the puma in California, 1976. *Carnivore* 1:92-96.
- Krulitz, L.M. 1979. Keynote: federal legal background for mitigation. In: G.A. Swanson (ed.). A mitigation symposium: a national workshop in mitigating losses of fish and wildlife habitats held at Fort Collins, Colorado on July 16-20, 1979. Pp. 19-26. USDA Forest Service General

- Technical Report RM-65, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.
- Krutzsch, P.H. 1955. Observations on the California mastiff bat. *Journal of Mammalogy* 36:407-414.
- Lack, D. 1933. Habitat selection in birds. *Journal of Animal Ecology* 2:239-262.
- Landres, P.B. 1983. Use of the guild concept in environmental impact assessment. *Environmental Management* 7:393-398.
- LaRoe, E.T. 1979. The biological basis for estuarine ecosystem mitigation. In: G.A. Swanson (ed.). *The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitats held at Fort Collins, Colorado, July 16-20, 1979*. Pp. 90-92. U.S. Forest Service General Technical Report RM-65.
- Layman, S.A. 1985. Riparian bird community structure and dynamics: Dog Island, Red Bluff, California. Pp. 589-597. In: R.E. Warner and K.M. Hendrix (eds.). *California riparian systems ecology, conservation and productive management*. University of California Press, Berkeley.
- Lehman, P. 1982. The status and distribution of the birds of Santa Barbara County, California. Master's Thesis, Department of Geography, University of California, Santa Barbara. 365pp.
- Likens, G.E. 1983. A priority for ecological research. *Bulletin of the Ecological Society of America* 64:234-243.
- Longhurst, W.M., A.S. Leopold, and R.F. Dasman. 1982. A survey of California deer herds-their ranges and management problems. *California Department of Fish and Game* 6:1-136.



- MacArthur, R.H., J. MacArthur, J. Preer. 1962. On bird species diversity. II. Prediction of bird census from habitat measurements. *American Naturalist* 96:167-174.
- Mader, H.J. 1984. Animal habitat isolation by roads and agricultural fields. *Biological Conservation* 29:81-96.
- Mahrtdt, C.A., T.A. Oberbauer, J.P. Rieger, J.R. Verfaillie, B.M. Browning, and J.W. Speth. 1976. Natural resources of coastal wetlands in northern Santa Barbara County. U.S. Fish and Wildlife Service, Coastal Wetland Series #14.
- Mallory, M.J. 1980. Potential effects of increased ground water pumpage on Barka Slough, San Antonio Creek Valley, Santa Barbara County, California. U.S. Geological Survey Water Resources Investigations 80-95.
- Mansfield, T.M., D.E. Conolly, and W.M. Longhurst. 1975. Condition of black-tailed deer fawns from oak woodland and chaparral habitat types. *California Nevada Wildlife Transactions* 1975:1-12.
- Manuwal, D.A. 1986. Characteristics of bird assemblages along linear riparian zones in western Montana. *Murrelet* 67:10-18.
- Marcot, B.G., M.G. Raphael, and K.H. Berry. 1983. Monitoring wildlife habitat and validation of wildlife habitat relationship models. *Transactions of the North American Wildlife and Natural Resources Conference* 48:315-329.
- Martin, N.D. 1960. An analysis of bird populations in relation to forest succession in Algonquin Provincial Park, Ontario. *Ecology* 41:126-140.
- Matkin, C. 1981. Observation of marine mammal interactions with some Alaskan fisheries. Marine Fishery Interaction Workshop, Vancouver, Washington. 3pp.

- McKnight, T.L. 1964. Feral livestock in Anglo America. University of California. Publications in Geography 16:1-78.
- Meents, J.K., J. Rice, B.W. Anderson, and R.D. Ohmart. 1983. Nonlinear relationships between birds and vegetation. Ecology 64:1022-1027.
- Meyers, J.P. 1983. Conservation of migrating shorebirds: staging areas, geographic bottlenecks, and regional movements. American Birds 37:23-25.
- Miller, D.J. 1974. Skindivers, abalone and sea otters. Outdoor California 35:1-4.
- Mills, J.N. 1986. Herbivores and early post fire succession in southern California chaparral. Ecology 67:1637-1649.
- Mitchell, A. 1986a. Deer spotlight census: section 6.4.3, U.S. Army Corps of Engineers wildlife resources management manual. Technical Report EL-86-53. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.
- Mitchell, A. 1986b. A white-tailed deer track count census: section 6.4.2, U.S. Army Corps of Engineers wildlife resources management manual. Technical Report EL-86-52. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.
- Motroni, R.S. 1985. Seasonal variation of bird numbers in a riparian forest. Pp. 578-586. In: R.E. Warner and K.M. Hendrix (eds.). California riparian systems ecology, conservation and productive management. University of California Press.
- Mount, L.E. 1968. Adaptation of swine. Pp. 277-291. In: E.S.E. Hafez (ed.). Adaption of domestic animals. Lea and Febiger, Philadelphia.
- Moyle, P.B. 1973. Effects of introduced bullfrogs, *Rana catesbeiana* on the native frogs of San Joaquin Valley, California. Copeia 1973:18-22.

- Moyle, P.B. 1974. Decline of the native fish fauna of the Sierra Nevada foothills, central California. *American Midland Naturalist* 92:72-83.
- Naydol, A.V. 1986. Fish and wildlife plan for Vandenberg Air Force Base, California. Revision number 2 for plan period January 1985 to January 1991. Vandenberg Air Force Base, California.
- Noss, R.F. and L.D. Harris. 1986. Nodes, networks, and mums: preserving diversity at all scales. *Environmental Management* 10:299-309.
- O'Brien, P.H., R.E. Kleba, J.A. Beck, and P.J. Baker. 1986. Vomiting by feral pigs after 1080 toxication: nontarget hazard and influence of anti-emetics. *Wildlife Society Bulletin* 14:425-432.
- O'Connor, R.J. 1981. Habitat correlates of bird distribution in British census plots. *Studies in Avian Biology* 6:553-537. In: C.J. Ralph and J.M. Scott (eds.). *Estimating numbers of terrestrial birds*.
- O'Connor, R.J. 1986. Dynamical aspects of avian habitat use. Pp. 235-240. In: J. Verner, M.L. Morrison, and C.J. Ralph (eds.). *Modeling habitat relationships of terrestrial vertebrates*. The University of Wisconsin Press, Madison.
- Orloff, S. 1976. Behavioral ecology of ringtails *Bassariscus astutus* in Sonoma and Napa counties. Research paper, Sonoma State College. 21pp.
- Orser, P.N. and D.V. Shure. 1972. Effects of urbanization on the salamander *Desmognathus fuscus*. *Ecology* 53:1148-1154.
- Ostfeld, R.S. 1982. Foraging strategies and prey switching in the California sea otter. *Oecologia* 53:170-178.
- Page, G.W. and L.E. Stenzel. 1981. The breeding status of the snowy plover in California. *Western Birds* 12:1-39.

- Page, G.W., D.W. Winkler, and C. Swarth. 1979. Breeding success of snowy plovers at Mono Lake, California. Refuges and Wildlife Resources Report. U.S. Fish and Wildlife Service, Sacramento, California. 21pp.
- Page, G.W., R. Ramar, N. Spear, C. Frederikson, L. Stenzel, J.S. Warriner, and J.C. Warriner. 1981. Distribution of snowy plovers on the west coast of the United States. Refuges and Wildlife Resource Report. U.S. Fish and Wildlife Service, Sacramento, California.
- Payne, R.B. 1973. The breeding season of a parasitic bird, the brown-headed cowbird in central California. Condor 75:80-94.
- Pearson, O.P., M.R. Koford, and A.K. Pearson. 1952. Reproduction of the lump-nosed bat (*Corynorhinus rafinesquii*) in California. Journal of Mammalogy 33:273-320.
- Pine, D.S. and G.L. Gerdes. 1973. Wild pigs in Monterey County, California. California Fish and Game 59:126-137.
- Poffenberger, D.L. 1979. An investigation of the movements of feral swine (*Sus scrofa*) in east central Florida. Master's Thesis. Florida Institute of Technology, Melbourne. 101pp.
- Pruett-Jones, S.G., M.A. Pruett-Jones, and R.L. Knight. 1980. The white-tailed kite in north and middle America: current status and recent population changes. American Birds 34:682-690.
- Ralls, K. and J. Ballou. 1983. Genetic diversity in California sea otters; theoretical considerations and management implications. Biological Conservation 25:209-232.
- Ralph, C.J. and B.D. Maxwell. 1984. Relative effects of a human and feral hog disturbance on a wet forest in Hawaii. Biological Conservation 30:291-303.

- Remsen, J.R., Jr. 1978. Bird species of special concern in California: an annotated list of declining of vulnerable bird species. California Department of Fish and Game, Nongame Wildlife Investigations, Wildlife Management Branch Administrative Report Number 78-1.
- Rice, J., B.W. Anderson, and R.D. Ohmart. 1980. Seasonal habitat selection by birds in the lower Colorado River Valley. *Ecology* 61:1402-1411.
- Roberts, T.H. and J.L. O'Neil. 1983. Habitat evaluation methods - examples and guidelines for selection. Pp. 266-269. In: J. Bell and T. Atterbury. Renewable resource inventories for monitoring changes and trends: proceedings of a symposium. Oregon State University, Corvallis.
- Root, R.B. 1967. The niche exploration pattern of the blue-gray gnatcatcher. *Ecological Monographs* 37:317-350.
- Salwasser, H., D.J. Thayer, and D.L. Young. 1980. The use of road-killed deer for assessing reproductive potential and winter condition of the Devil's Garden Interstate mule deer herd. *California Fish and Game* 66:105-111.
- Salwasser, H., C.K. Hamilton, W.B. Krohn, J.F. Kopscomb, and C.H. Thomas. 1983. Monitoring wildlife and fish: mandates and their implications. *Transactions of the North American Wildlife and Natural Resources Conference* 48:297-307.
- Samson, F.B. and K.L. Knopf. 1982. In search of a diversity ethic for wildlife management. *Transactions of the North American Wildlife and Natural Resources Conference* 47:421-431.
- Schamberger, M. and A. Farmer. 1978. The habitat evaluation procedures: their application in project planning and impact evaluation. *Transactions North American Wildlife and Natural Resources Conference* 43:274-283.
- Schamberger, M., A.H. Farmer, and J.W. Terrel. 1982. Habitat suitability index models: introduction. USDA Fish and Wildlife Service, Washington, D.C.

- Schamberger, M., C. Short, and A. Farmer. 1983. Evaluating wetlands as wildlife habitat. USDA Fish and Wildlife Service, Washington, D.C.
- Schmalzer, P.A., D.E. Hickson, and C.R. Hinkle. 1988. Vegetation studies on Vandenberg Air Force Base, California. NASA Technical Memorandum 100985.
- Schroeder, R.L. 1987. Community models for wildlife impact assessment: a review of concepts and approaches. U.S. Fish and Wildlife Service, Biological Report 87(2). 41pp.
- Scott, J.M., M. Hoffman, D. Ainley, C.F. Zeilemaker. 1974. Range expansion and activity patterns in rhinoceros auklets. *Western Birds* 5:13-20.
- Scotter, G.W. 1980. Management of wild ungulate habitat in the western U.S. and Canada: a review. *Journal of Range Management* 33:16-27.
- Severinghaus, W.D. 1981. Guild theory development as a mechanism for assessing environmental impact. *Environmental Management* 5:187-190.
- Severinghaus, W.D. 1982. Effects of tracked vehicle activity on bird populations. *Environmental Management* 6:163-169.
- Short, H.L. 1983. Wildlife guilds in Arizona desert habitats. Bureau of Land Management Technical Note 362.
- Short, H.L. and K.P. Burnham. 1982. Technique for structuring wildlife guilds to evaluate impacts on wildlife communities. USDA Fish and Wildlife Service. Special Scientific Report-Wildlife No. 244.
- Singer, F.J., W.T. Swank, and E.C. Clebsch. 1984. Effects of wild pig rooting in deciduous forest. *Journal of Wildlife Management* 48:469-473.
- Smith, D.C. 1983. Factors controlling tadpole populations of the chorus frog (*Pseudacris triseriata*) on Isle Royale, Michigan. *Ecology* 64:501-510.

- Smith, J.P. 1981. Cowbird parasitism, host fitness, and age of the host female in an island song sparrow population. *Condor* 83:152-161.
- Smith, J.P. and R.J. Atkins. 1979. Cowbird parasitism on common bushtit nest. *Wilson Bulletin* 91:122-123.
- Steele, B.B., R.C. Bayn, Jr., and C.V. Grant. 1984. Environmental monitoring using populations of birds and small mammals: analyses of sampling effort. *Biological Conservation* 30:157-172.
- Stenzel, L.E., S.C. Peaslee, and G.W. Page. 1981. Mainland coast. Pp. 6-16. In: G.W. Page and C.E. Stenzel (eds.). *The breeding status of the snowy plover in California*. *Western Birds* 12:1-40.
- Stephenson, M.D. 1977. Sea otter predation on pismo clams in Monterey Bay. *California Fish and Game* 63:117-120.
- Storer, T.I. 1925. A synopsis of the amphibia of California. University of California Publications in Zoology 27:1-342.
- Strand, D.K. 1980. Reproductive ecology and behavior of the Florida feral hog (*Sus scrofa*). Master's Thesis. Florida Institute of Technology, Melbourne. 162pp.
- Svardson, G. 1949. Competition and habitat selection in birds. *Oikos* 1:157-174.
- Sweet, S.S. 1983. Mechanics of a natural extinction event: *Rana boylei* in southern California. 31st Annual Meeting of the Herpetologists' League, University of Utah.
- Szaro, R.C. 1986. Guild management: an evaluation of avian guilds as a predictive tool. *Environmental Management* 10:681-688.
- Szaro, R.C. and R.P. Balda. 1982. Selection and monitoring avian indicator species: an example from a ponderosa pine forest in the southwest.

- USDA Forest Service. General Technical Report RM-89. Rocky Mountain Forest and Range Equipment Station, Fort Collins, Colorado.
- Szaro, R.C. and M.D. Jakle. 1985. Avian use of a desert riparian island and its adjacent scrub habitat. *Condor* 87:511-519.
- Taber, R.D. 1953. Studies of black-tailed deer reproduction on three chaparral cover types. *California Fish and Game* 39(2):177-186.
- Taber, R.D. and R.F. Dasmann. 1958. The black-tailed deer of the chaparral: its life history and management in the north coast range of California. California Department of Fish and Game Bulletin 8. 163pp.
- Tate, J., Jr. 1981. The blue list for 1981. *American Birds* 35:3-10.
- Tate, J., Jr. and D.J. Tate. 1982. The blue list for 1982. *American Birds* 36:126-135.
- Taylor, D.M. and C.D. Littlefield. 1986. Willow flycatcher and yellow warbler response to cattle grazing. *American Birds* 40:1169-1173.
- Terborgh, J. 1976. Island biogeography and conservation: strategy and limitation. *Science* 193:1029-1030.
- Thomas, J.W. 1982. Needs for and approaches to wildlife habitat assessment. Transactions of the North American Wildlife and Natural Resources Conference, 1982. 47:35-46.
- URS Corporatin. 1987. Draft mineral resource management plan. URS Corporation. Santa Barabara, California.
- U.S. Fish and Wildlife Service. 1980. A habitat as a basis for environmental assessment. USDA Fish and Wildlife Service, 101 EMS, Washington, D.C.
- U.S. Fish and Wildlife Service. 1982. Southern sea otter recovery plan. U.S. Fish and Wildlife Service, Washington, D.C.



- U.S. Fish and Wildlife Service. 1983a. Habitat evaluation procedures (HEP).  
USDA Fish and Wildlife Service, 102 ESM, Washington, D.C.
- U.S. Fish and Wildlife Service. 1983b. Standards for the development of  
habitat suitability index models. USDA Fish and Wildlife Service, 103  
ESM, Washington, D.C.
- Van Horne, B. 1983. Density as a misleading indicator of habitat quality.  
*Journal of Wildlife Management* 47:893-901.
- Van Vuren, D. 1984. Diurnal activity and habitat use by feral pigs on Santa  
Cruz Island, California. *California Fish and Game* 70:140-144.
- Vaughan, T.A. 1959. Functional morphology of the three bats: *Eumops*, *Myotis*,  
*Macrotus*. University of Kansas Publications of the Museum of Natural  
History 12:1-153.
- Verner, J. 1983. An integrated system for monitoring wildlife on the Sierra  
National Forest. Transactions of the North American Wildlife and Natural  
Resources Conference 48:355-366.
- Verner, J. 1984. The guild concept applied to the management of bird  
populations. *Environmental Management* 8:1-14.
- Verner, J., M.L. Morrison, and C.J. Ralph (eds.). 1986. Wildlife 2000: modeling  
habitat relationships of terrestrial vertebrates. The University of  
Wisconsin Press, Madison. 470pp.
- Wagstaff, F.J. 1986. Economic issues of grazing and riparian area  
management. Transactions of the North American Wildlife and Natural  
Resources Conference 55:272-279.
- Warner, J.S. and R.L. Rudd. 1975. Hunting by the white-tailed kit (*Elanus*  
*leucurus*). *Condor* 77:226-230.

- Warriner, J.S., J.C. Warriner, G.W. Page, and L.E. Stenzel. 1986. Mating system and reproductive success of a small population of polygamous snowy plovers. *Wilson Bulletin* 98:15-37.
- Weber, Y.B. 1980. Habitat evaluation procedures of the U.S. Fish and Wildlife Service. Forest, Wildlife and Range Experiment Station Contribution 217. University of Idaho, Moscow.
- Webster, R.E. 1980. Bell's vireo (*Vireo bellii*) survey. Vandenberg AFB unpublished report. U.S. Fish and Wildlife Service. Endangered Species Office, Order #11310-0150-80.
- Welker, H.J. 1986. Fawn bearing habitat of the Lake Hollow deer herd, Tehama County, California. *California Fish and Game* 72:94-98.
- Wendell, R.E., R.A. Hardy, J.A. Ames, and R.T. Barge. 1986. Temporal and spatial patterns in sea otter, *Enhydra lutris*, range expansion and in the loss of pismo clam fisheries. *California Fish and Game* 72:197-212.
- Westoby, M., G.R. Rost, and J.A. Weis. 1976. Problems with estimating herbivore diets by microscopically identifying plant fragments from stomachs. *Journal of Mammalogy* 57:167-172.
- Whitaker, G.A. 1979. NEPA regulations, a new tool for achieving better mitigation. In: G.A. Swanson (ed.). The mitigation symposium: a national workshop on mitigating losses of fish and wildlife habitats held at Fort Collins, Colorado on July 16-20, 1979. Pp. 532-535. U.S. Forest Service General Technical Report RM-65. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.
- Whitcomb, R.F., J.F. Lynch, P.A. Opler, and C.S. Robbins. 1976. Island biogeography and conservation: strategy and limitations. *Science* 193:1030-1032.

- Wiens, J.A. 1977. On competition and variable environments. *American Scientist* 65:590-597.
- Wiens, J. and J. Rotenberry. 1981. Censusing and the evaluation of avian habitat occupancy. *Studies in Avian Biology* 6:522-532. In: C.J. Ralph and J.M. Scott (eds.). *Estimating numbers of terrestrial birds*.
- Wilbur, S.R. 1974. The literature of the California least tern. U.S. Bureau of Sport Fisheries and Wildlife, Special Scientific Report - Wildlife No. 175, Washington, D.C. 18pp.
- Wild, P. and S. Ames. 1974. A report on the sea otter *Enhydra lutris* in California. California Department Fish Game Marine Research Technical Report 20. 94pp.
- Williams, D.F. 1986. Mammalian species of special concern in California. California Fish and Game Wildlife Management Administrative Report 87-1, Sacramento. 96pp.
- Williams, P.L. and W.D. Koenig. 1980. Water dependence of birds in temperate oak woodland. *Auk* 97:339-350.
- Willis, E.O. 1974. Populations and local extinctions of birds on Barro Colorado Island, Panama. *Ecological Monographs* 44:153-169.
- Wilson, M.F. 1974. Avian community organization and habitat structure. *Ecology* 55:1017-1021.
- Wilson, R.A. 1980. Snowy plover nesting ecology on the Oregon coast. Master's Thesis. Oregon State University, Corvallis. 41pp.
- Wood, G.W. and R.H. Barrett. 1979. Status of wild pigs in the United States. *Wildlife Society Bulletin* 7:237-246.
- Woodhouse, C.D., Jr., R. Cowen, and L. Wilcoxon. 1977. A summary of knowledge of the sea otter, *Enhydra lutris* L., in California and an

- appraisal of the completeness of the biological understanding of the species. Marine Mammal Commission.
- Wynne-Edwards, J.C. 1962. Animal dispersion in relation to social behavior. Oliver and Boyd, Edinburg, Scotland. 653pp.
- Zemba, R.L. and B.W. Massey. 1981. A census of the light-footed clapper rail in California. Western Birds 12:87-99.
- Zemba, R. and B.W. Massey. 1987. Seasonality of vocalizations by light-footed clapper rails. Journal Field Ornithology 58:41-48.
- Zweifel, R.G. 1955. Ecology, distribution, and systematics of frogs of the *Rana boylii* group. University California Publications in Zoology 54:207-292.

## 6.0 Appendix 1. Rationale for long-term Monitoring of Wildlife Resources

There are many federal agency mandates for monitoring wildlife (Salwasser et al. 1983); proper management of environmental resources requires direct biological monitoring (Karr 1987). Monitoring is a legal mandate to assure that mitigation measures and other commitments associated with a project are carried out and have the intended effects. This is important because in many cases, neither theory nor data are well founded enough so that impacts are always accurately predictable. Impact assessment often lacks credibility; common problems include a lack of a rigorous quantitative approach and the failure to follow actions with monitoring. Data collected by monitoring programs gives credibility to the environmental assessment and impact statement process and to the development of effective land use plans (Halvorson 1984).

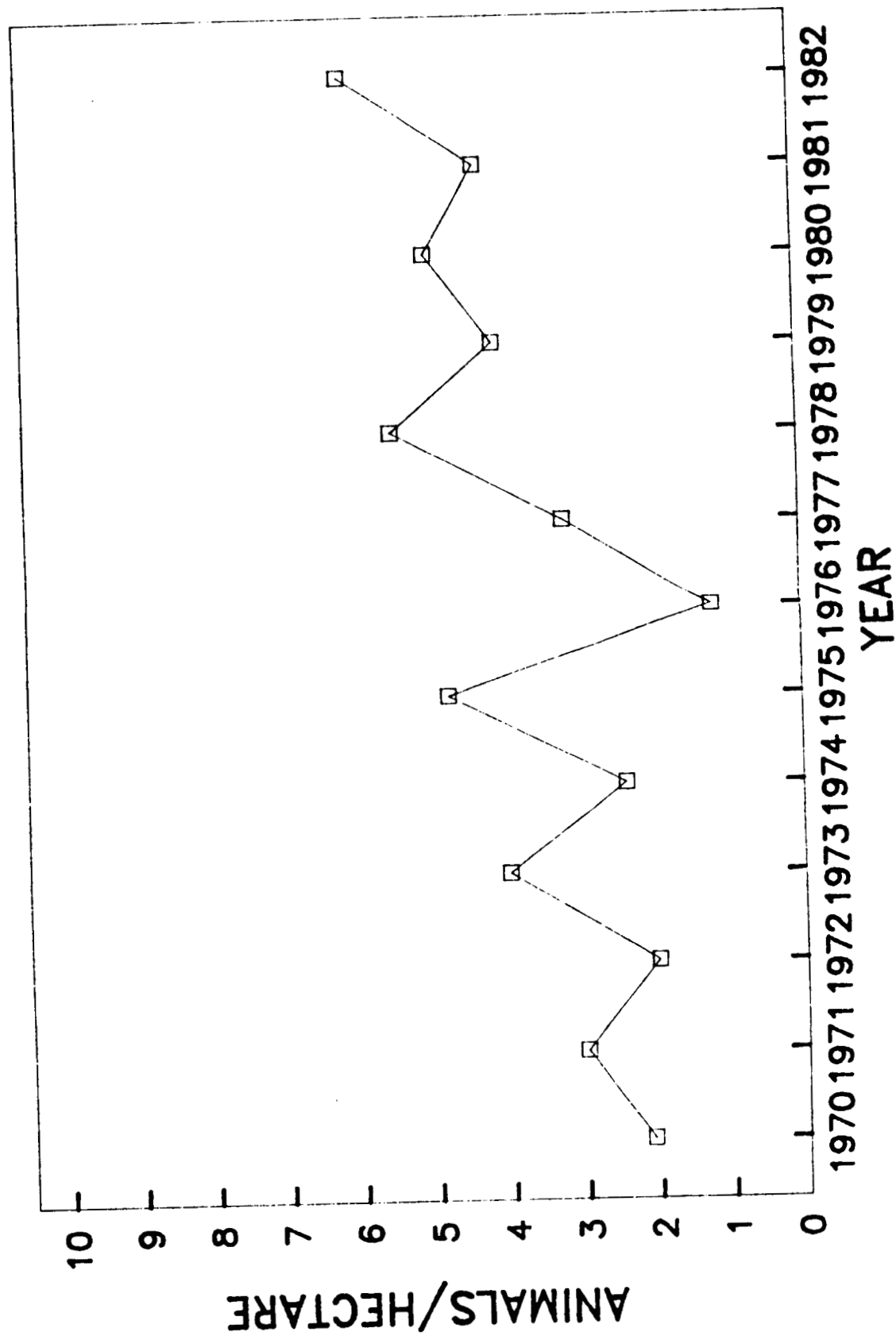
Monitoring is needed to provide resource managers with feedback on their understanding of the natural resource and the effectiveness of their management. Without data, decision making involves predictions and interpretations based on perceptions of the natural environment and extrapolations of studies performed under other circumstances.

Successful wildlife monitoring programs provide ecologically and statistically valid information that is sufficiently sensitive to detect significant trends or changes over a continuous time period and is cost effective. The reliability levels of statistics used in monitoring should depend on the decision risk involved, natural variability, and the technology and resources available (Salwasser et al. 1983). Not all programs are successful; unsuccessful programs seldom have published data and the data is of a short-term nature that cannot be compared with other monitoring studies (Hirst 1983). Monitoring programs need carefully formulated objectives designed to answer questions of

management, maintain sustainable and reliable funding (Hirst 1983, Halvorson 1984), and have periodic outside review (Hirst 1983).

Monitoring is an activity (involving measurements) and a process (needing constant evaluation and refinement) since it involves a collection of data subject to assumptions, management objectives, sampling effectiveness, and budgets (Salwasser et al. 1983). Short-term studies provide only a glimpse of events at a point in time. Therefore, there is a critical need for long-term study in monitoring programs rather than short-term study. Several years data are needed to determine relationships concerning habitat suitability (Anderson 1981, Wiens and Rotenberry 1981, Van Horne 1983, O'Connor 1986, Verner et al. 1986). Examples of the importance of long-term considerations are provided below. Young red-spotted newts were marked for identification and surveys were conducted to locate the marked newts for six years. Results led to conclusions that the breeding populations were derived from immigration from ponds far away, since newts did not appear to return to their breeding grounds. Not until the seventh year did the long-absent newts, marked when they were young, reappear; thus, it took a long-term study to determine that newts took four to eight years to reach maturity and return to the breeding ponds (Gill et al. 1983). Likens (1983) presents long-term data from R.T. Holmes where different conclusions regarding expansion or decline of bird populations can be reached if only a few years' data are used to determine trends. A comprehensive assessment of biological resources of VAFB was previously made in a period of less than a year, but it represented only a snapshot in time (Coulombe and Cooper 1976). Figure 1 presents a hypothetical example where, if one sampled only in 1973 and 1976, one could have concluded the population is declining

Figure 1. LONG TERM POPULATION TRENDS



when the overall trend suggests that the population is increasing. Other examples are provided by Likens (1983) and Halvorson (1984).

One of the most difficult aspects of developing a monitoring program is to determine what are the most important components to monitor, given budget constraints. When little preliminary information is available, it may be difficult to determine how the most important wildlife components should be studied. A sequence of short-term studies may be needed for successive refinements into long-term programs. Components emphasized for monitoring should include: 1) species listed as endangered, threatened, rare, or declining; 2) species that are indicators of habitat quality and/or management influences; and 3) species for which habitat on VAFB is important for maintenance of the species in the surrounding region.

There are several reasons for including state-listed species and other regionally declining species of special concern in addition to federally listed species. These species often are good indicators of environmental quality, representing the "health" of the various habitats, since they represent species for which habitat is declining at a rapid rate or species that are particularly sensitive to change. They also represent species that are presently candidates for federal listing or can be expected to be candidates in the future. Legal mandates to protect and enhance environmental quality not only refer to endangered species but also refer to the wildlife community in general.

Data collected from a monitoring program can be used to develop strategies to mitigate the impact of proposed projects. Studies of habitat can be used to map the most and least favorable sites for future development and determine habitat characteristics that can be managed to enhance habitat in one area to offset development elsewhere. Mitigation, with respect to wildlife and endangered species, is a requirement for federal agencies that have a firm



legal foundation (Krulitz 1979, LaRoe 1979, Whitaker 1979). Some habitat management is necessary with or without future project development. Management can no longer just consider preservation of habitat because most systems and their natural controls have been altered.

The basis to a habitat approach to monitoring is that if enough is known about habitat needs and tolerances of wildlife, one should be capable of inferring trends in populations by monitoring trends in habitat. One cannot, however, rely only on monitoring habitat parameters (vegetation parameters, water quality) to monitor animal populations. Monitoring of both wildlife populations and habitat parameters should be focused to achieve the objectives of monitoring. Animals and their habitat operate as a functional unit, so that a monitoring plan that focuses solely on either habitat or animal species is incomplete and in the long run will fail to detect underlying cause and effect relationships (Salwasser et al. 1983). Water quality monitoring is not sufficient to maintain important environmental resources. Water resource management cannot reliably depend only on physical and chemical parameters as indicators of biological conditions (Karr and Dudley 1981, Karr 1987). Such an approach must be replaced by an approach that includes direct biological monitoring of the resource in question.

Dozens of habitat evaluation methods have been developed (Hawkes et al. 1983, Roberts and O'Neil 1983). For example, these concepts are used by the U.S. Forest Service in development of the Wildlife and Fish Habitat Relationships (WFHR) System (Thomas 1982) and the U.S. Fish and Wildlife Service in development of Habitat Evaluation Procedures (HEP) (Weber 1980). Habitat evaluation procedures have been developed by the U.S. Fish and Wildlife Service as standardized procedures using habitats as the basis for environmental assessment. The purpose of HEP is to provide a quantifiable,

uniform assessment of project impacts of fish and wildlife (Hirsch et al. 1979). The procedures rely on the development of Habitat Suitability Indexes (HSI) for particular species based upon physical and biological characteristics of the habitat. Standards have been developed to construct indices that can place a habitat within the range of 0 to 1.0. The Habitat Units (HU) or value of an area being evaluated can be found by determining the HSI value of the habitat and then multiplying this value by the acreage of concern. These procedures can be used in the inventory of baseline conditions, quantification of impacts, formulation or comparison of alternatives, and compensation for losses by affecting a net increase in habitat units by management methods (Schamberger and Farmer 1978, Farmer et al. 1982).

The HEP procedures are standardized in Parts 101, 102, 103, and 104 of the Ecological Services Manual (U.S. Fish and Wildlife Service 1980, 1983a, b). HSI models have been developed for numerous species, and an introduction to these is presented by Schamberger et al. (1982). Handbooks for using these procedures have been developed for specific regions such as Missouri (Flood et al. 1977) or communities such as cypress-gum swamps (Schamberger et al. 1983).

Models have been developed for at least 12 species that occur at VAFB, but they have not been validated for use at VAFB and do not include many species of special concern of VAFB. Models should be validated prior to use (Marcot et al. 1983). Models can be developed from field investigations and literature reviews relating the importance of habitat parameters to a species. For example, a riparian bird species of special concern may prefer a certain range of vegetation height, a preferred range of cover by particular vegetation components, and the presence of a minimum number of snags. This can be investigated by surveying the importance of a range of riparian conditions to

various avian species and measuring carefully selected habitat parameters at the study sites. The data can then be used to produce an index where riparian sites on VAFB can be quantified relative to the importance to the species of special concern. Justification of such an approach is based on habitat selection principles that assume it is adaptive for an animal to select certain sites over others (Flather and Hoekstra 1985) and that density frequently decreases from areas of more suitable habitat to areas of less suitable habitat (Andrewartha and Birch 1954, Wynne-Edwards 1962).

All studies should consider limitations to the approaches utilized; for example, there are limitations to the frequently overlooked assumption that density is a direct measure of habitat quality when there is a lack of demographic information (Van Horne 1983, O'Conner 1981, 1986). Some examples below describe how measures of species abundance can be misleading. Certain habitat conditions in a particular season can be a disproportionately contributing factor to reproduction and survival patterns in some species. Basing habitat assessments on data collected from other seasons can produce misleading results. For example, ephemeral ponds during the breeding season may be necessary for some amphibians; dense cover may be necessary during the fawning season for deer. A one year study of densities may reflect conditions in the recent past or current conditions that are temporary and may not reflect long-term trends in habitat quality (Van Horne 1983). A "source and sink" structuring to populations has been suggested (Wiens and Rotenberry 1981) where some areas ("sources") may have reproductive rates that exceed mortality rates and other areas ("sinks") may have no successful reproduction or have mortality rates that exceed reproductive rates. The areas that serve as "sources" are of prime importance in maintenance of populations. Social interactions may prevent subdominant animals from entering high-quality

habitat. Individuals may collect in marginal habitat during favorable years so that densities may be higher in these areas than in areas of optimal habitat. During a year of high-overall density, density may be a misleading indicator for some species (O'Connor 1981, Van Horne 1983).

Steele et al. (1984) suggest that monitoring communities as opposed to only indicator species integrates information from many ecosystem components and is less sensitive to unexplained population fluctuations of single species. Not only are models useful for single species but community models can also be used, although there are limitations to such models (Schroeder 1987). One example is an Arizona guild and habitat layer model where the vertical dimension and complexity are used to determine the wildlife community (Short 1983). Species diversity should not be used as a sole indicator of community organization. Increasing diversity within a habitat may not increase regional diversity due to the exclusion of more specialized species (Samson and Knopf 1982, Noss and Harris 1986), so that there is a need to identify species that have specialized requirements.

The usage of the guild concept to streamline environmental monitoring and assessment tasks has been suggested by numerous authors (Johnson 1981, Severinghaus 1981, Jarvinen and Vaisunen 1979, Short and Burnham 1982, Landres 1983, Verner 1984). The usage of the term guild was originally proposed by Root (1967) as a "group of species that exploit the same class of environmental resources in a similar way." Defining assemblages of species into guilds according to their requirements for reproduction and feeding has been the approach of Short (1983), Short and Burnham (1982), and Verner (1984). This is probably the most useful approach for environmental resource evaluation, since the guilds constructed in such a manner are likely to respond to changes in habitat. Recent proposals (Verner 1984) have indicated that there

is great promise in using whole wildlife guilds for monitoring to determine whether different zones of a habitat maintain the capability to support wildlife populations. Landres (1983) and Verner (1984) have criticized the approach of using only an indicator species to extrapolate impacts for the whole guild. One major advantage of using whole guilds and not just indicator species is that data is developed for a group of species reducing the number of points needed for an adequate sample and minimizing cost. The extrapolation of impacts to all members of a guild, however, is not always valid (Landres 1983, Szaro 1986). Although guild methods are receiving considerable attention, more studies are needed before they can be recommended as a management tool (Schroeder 1987) unless a guild method is one of several other methods that compliment each other.

The discussion above indicates the importance of monitoring and the need for a scientific approach to objectives and methods for a monitoring program to be successful. The San Diego State Study (Coulumbe and Cooper 1976, Coulumbe and Mahrtdt 1976) provided a good beginning for the development of a BMP. As indicated above, studies occurring on an infrequent basis will not provide a real understanding of changes in the ecology of VAFB. Wildlife resources themselves must be investigated directly because reliable inferences can not be made only by monitoring other base components. A monitoring program can be structured to monitor the base ecology and to provide information needed by the natural resources staff of 1 STRAD/ET and those responsible for preparing environmental assessments and mitigation strategies for future projects.



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